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ABSTRACT

This study conducted a statistical analysis to look at the participation and achievement of Black, Hispanic, and female secondary education students in mathematics, science, and advanced technology programs in schools in Virginia, compared to those of White students and male students. In particular, the study applied descriptive and inferential statistical methods to develop percentages, frequencies, means, and binomial proportionality statistics using data collected via the Student Enrollment Survey and the Virginia Vocational Education Reporting System. For measures of student achievement, the study analyzed data on awarding of diplomas, scores from a national assessment, enrollment in five Virginia magnet schools, scores on a State Assessment Program instrument, participation in student science competitions, and enrollment in advanced programs. The analysis found that Black and Hispanic students were participating and achieving at rates lower than were White students; the difference in both participation rates and achievement was greater for Black students than for Hispanic students; and female students participated and achieved on a par with male students in most facets of mathematics and science studies. Six appendixes present statistical analyses of enrollment data, the Virginia State Department of Education work plans, a student enrollment survey form, statistical summaries, Virginia science and technology magnet school enrollment data, and a list of secondary school course offerings. A 16-item bibliography is included. (JB)

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April 1992

A Study of the Participation and Achievement of Black, Hispanic and Female Students in Mathematics, Science and Advanced Technologies in Virginia Secondary Schools

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RFP # 91-36/46

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EXECUTIVE SUMMARY

A survey of the current literature describes a lack of participation and achievement of minority students, especially black and Hispanic, in the areas of mathematics, science, and advanced technologies. Research suggests that some minority students, especially Hispanic and black, have significantly lower levels of achievement in mathematics, science, and technology than do white students. The purpose of this study was to assess the achievement and participation of black, Hispanic, and female students in mathematics, science, and technology courses as compared to that of white students and male students, as appropriate, in Virginia public schools. Data were analyzed to determine if a discrepancy existed between the achievement and participation of the white student population and that of black and Hispanic students, and/or between male and female students in Virginia's public schools.

Educational intervention strategies which have been successful in reducing the disparity in minority and female achievement and participation in mathematics, science, and technology programs in secondary schools are also included in this report. The intervention strategies suggested are now in place either in schools or as community efforts. The ultimate goal is that all students, regardless of race or gender, achieve success and become literate in mathematics, science, and technology.

PROCEDURE

The National Prospective on minority participation and achievement in mathematics, science, and technology was determined through a review of current literature including an ERIC search. Secondly, data collected via the Student Enrollment Survey (SES, 1991) and the Virginia Vocational Education Reporting System (VERS, 1991) were evaluated. These enrollment data were analyzed by gender and ethnicity, using descriptive and inferential statistical methods, to develop percentages, frequencies, means, and binomial proportionality statistics An explanation of the use of the binomial proportionality status appears in Appendix A. Female enrollment was compared to male enrollment for mathematics, science, and technology. Minority ethnic enrollments were compared to white enrollment and to the percentage of the total sample represented by each minority ethnic group.

In addition, the following data were analyzed by gender and ethnicity as measures of student achievement in mathematics, science, and technology:

- The state 1990 aggregate data regarding the awarding of diplomas by gender and ethnicity
- Scores of the Virginia students participating in the 1991 National Assessment of Educational Progress (NAEP) mathematics proficiency test
- 1991-92 enrollment in the five Virginia magnet schools for science and technology
- Division mathematics and science scores on the 1990-91 Virginia State Assessment Program (VSAP) fourth, eighth and eleventh grade tests
- Participation in the Virginia Junior Academy of Science (VJAS) 1991 student competition
- The advanced course enrollment and demographics of student participants in the National Science Scholars Program for 1991 by gender and ethnicity.

FINDINGS

Black and Hispanic students were found to participate and achieve in mathematics, science, and technology at rates lower than those found for white students. This was especially noted in advanced courses. The difference in both participation rates and achievement was greater for black students than for Hispanic students. Female students participated and achieved on par with male students in most facets of mathematics and science studies. An exception was found in advanced mathematics participation where the percentage of male students (52.6 %) exceeded that of female students (47.4%) by approximately five percentage points, a significant difference. Male students also had greater participation rates in VJAS mathematics competition where 85 percent of the participants were male. In addition, black and female students are represented at a disproportionately low rate when compared to white males in the current Virginia science and technology magnet school enrollment.

The enrollment of black (8.0%) and female (12.3%) students in the most advanced technology program, pre-engineering, was lower than the respective population percentages (19.4% and 50.8%). The population percentages cited are the percentages of eleventh-grade students in the Virginia State Assessment Program by gender and ethnicity.

The rate of enrollment and achievement test scores of white students exceeded that of black students in mathematics, and science. There was no significant difference in the rate of enrollment of Hispanic and white students in academic science courses. However, differences were noted on achievement test scores of Hispanic students in mathematics and science and in the rate of enrollment of Hispanic students in mathematics and technology compared to white students.

RECOMMENDATIONS

The Department of Education should form a team that includes mathematics, science, and technology educators to plan a symposium for developing a strategic plan to promote systematic improvements in the participation (enrollment) and achievement of black, Hispanic, and female students in mathematics, science, and technology. The planners should consider, but not limit discussion to, the following potential intervention activities and strategies. These suggested strategies, as indicated in the parenthetical references, are based on programs and strategies successfully implemented both nationally and in Virginia.

- Develop special pre-school mathematics, science, and technology readiness programs. Such programs have been modeled in Virginia, but as far as was determined, on a very small scale. (The Dwight D. Eisenhower Mathematics and Science Education Act)

- Develop special programs for secondary students such as after-school and Saturday enrichment programs. Such programs, targeted at underrepresented students, have provided mathematics, science, and technology enrichment both nationally and in Virginia. (National Science Foundation)

- Provide mentorship, scholarship and internship programs and job shadowing opportunities by business/industry and the public sector. These programs have been modeled in Virginia's science and technology magnet schools as well as in initiatives throughout the Commonwealth. (Student Enrollment Survey)

- Develop instructional models to improve teacher inservice and preservice training to address the special educational needs of black, Hispanic, and other under-represented students. (Southeastern Consortium for minorities in Engineering)

- Identify teacher recruitment practices that recognize the need for appropriate role models for minority and female students. (National Science Foundation, Student Enrollment Survey)

- Develop programs for parents that prepare them to help their children make course selection decisions and consider career choices in mathematics, science, and technology. (Student Enrollment Survey)

- Develop mathematics and science enrichment programs outside of the public secondary setting, supported cooperatively by the Board of Education, the State Council of Higher Education, and business and community organizations. These enrichment programs develop the interest and achievement of minority and female students in mathematics and science and provide access to such instruction to a larger number of students. (National Science Foundation)

- Develop and implement classroom instructional strategies that encourage female students to pursue advanced physical science courses and mathematics studies. (The Mid-Atlantic Center for Sex Equity)

The strategic plan developed should be integrated into the Department of Education's educational reform plans such as World Class Education (WCE) and Virginia Quality Education for Science and Technology (V-QUEST).

It is further recommended that each individual school division evaluate the distribution of its student population in applied/general, academic, and advanced academic mathematics, science, and technology courses, by gender and ethnicity. If minority/female participation rates are revealed to be lower than that of white/male students, a local strategic plan should be developed and implemented to address increasing the participation rate of the underrepresented.

PREFACE

This report on the achievement of black, Hispanic, and female students in mathematics, science, and technology was conducted in response to Department of Education RFPs 91-36 and 91-46 by an interdisciplinary team of staff members:

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ACKNOWLEDGMENT

The Department of Education gratefully acknowledges the assistance of the Virginia school divisions for providing the information necessary to complete this study.

A STUDY OF THE ACHIEVEMENT AND PARTICIPATION OF BLACK, HISPANIC, AND FEMALE STUDENTS IN MATHEMATICS, SCIENCE, AND ADVANCED TECHNOLOGIES IN VIRGINIA SECONDARY SCHOOLS

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INTRODUCTION

This study was conducted to determine the status of the achievement and participation of black, Hispanic, and female students in mathematics, science, and technology in Virginia schools as compared to the achievement and participation of white and male students in the same courses. The study team also sought to identify intervention strategies and initiatives to improve the achievement and participation rates of those student groups for whom the data identified a need.

As directed by Department of Education RFPs 91-36 and 91-46, the study team attempted to address the following issues:

- Determine if black and Hispanic student achievement in mathematics and science is significantly lower than the achievement of the total population of students in Virginia.
- Determine if participation of black and Hispanic students in advanced level mathematics and science courses is significantly lower than for the total population of students in Virginia.
- Determine if female student achievement and participation in mathematics, science, and technology is significantly lower than that of male students in Virginia.
- Determine the magnitude of disparity in achievement and participation of between and among the ethnic groups studied and establish the degree of need for strategic intervention.
- Identify mathematics, science, and technology programs which have proven successful in improving the achievement of minority, and female students.
- Develop a strategic plan for integrating identified intervention programs into Department of Education Common Core of Learning, Restructuring, V-QUEST, and other reform initiatives.

PROCEDURE

The approach adopted by the study team involved the following procedure. The National Prespective on minority participation and achievement in mathematics, science, and technology was determined through a review of current literature including an ERIC search. Secondly, data collected via the Student Enrollment Survey (SES, 1991) and the Virginia Vocational Education Reporting System (VERS, 1991) were evaluated. These enrollment data were evaluated by gender and ethnicity, using descriptive and inferential statistical methods, to develop percentages, frequencies, means, and binomial proportionality statistics. Female enrollment was compared to male enrollment for each discipline studied, while minority ethnic enrollments were compared to white enrollment and to the percentage of the total sample represented ethnic groups.

In addition, the following data were analyzed by gender and ethnicity as measures of student achievement on tests in mathematics, science, and technology:

- Virginia state 1990 data regarding the awarding of diplomas by gender and ethnicity
- Scores on the 1991 National Assessment of Educational Progress (NAEP) mathematics proficiency test
- 1991-92 enrollment in the five Virginia magnet schools for science and technology
- Division mathematics and science 1990-91 scores on the Virginia State Assessment Program (VSAP) fourth, eighth and eleventh grade tests
- Participation in the Virginia Junior Academy of Science 1991 student competition
- Advanced course enrollment of student participants in the National Science Scholars Program for 1991 by gender and ethnicity

LIMITATIONS

Information and data for this study were collected subject to several limiting conditions. These conditions were considered in developing the findings and recommendations for this report.

- While an attempt was made to acquire data from the entire Virginia secondary school population data were received from schools representing 82 percent of school divisions. The sample is however, assumed to be representative of the Virginia secondary school population.

- Achievement data were obtained from state and national assessments in which Virginia students participated but not specifically collected for this study.

- Achievement and participation are results of multiple events that include teacher and parent expectations, instructional strategies, peer group pressures, and availability of incentives and local programs to increase interest in certain subject areas. Therefore it should be recognized that variables other than those examined in this study affect achievement and participation.

- The study focused on student participation and achievement in secondary mathematics, science, and technology in Virginia's public schools, with the exception of VSAP data which included other grade levels.

- The technology education data from the Virginia Vocational Education Reporting System is an unduplicated enrollment count. The count of students in the several technology education programs can vary from that presented herein because students enrolled in more than one program were only counted in one program. The total count represented all students enrolled in vocational programs but the actual enrollment for individual programs may be greater than reported.

DEFINITION OF TERMS

The following definitions and descriptions of terms are presented to provide an understanding of these terms as used in this report.

- **Participation**: Enrollment of students in specific courses or course levels

- **Applied/General Courses**: Courses designed for students perceived to be of lower ability or to lack the appropriate preparation for higher level course

- **Academic Courses**: Courses designed for students perceived to be of average to high ability

- **Advanced Academic Courses**: Courses designed for students perceived to have high ability

- **Unduplicated Enrollment**: A one-time count of students who completed more than one vocational course

FINDINGS: STATUS OF BLACK, HISPANIC, AND FEMALE PARTICIPATION AND ACHIEVEMENT IN MATHEMATICS, SCIENCE, AND TECHNOLOGY: THE NATIONAL PROSPECTIVE

A study Changing America: The New Face of Science and Engineering, published in 1989 by the Task Force on Women, Minorities, and the Handicapped in Science and Technology, reported that in the United States, blacks comprise only 2 percent of all employed scientists and engineers even though they make up 12 percent of the general population. In 1989, blacks earned 5 percent of the bachelor's degrees and one percent of the Ph.Ds in science and engineering. In 1988, only 47 blacks earned doctorates in science and only 15 earned them in engineering. The Task Force study indicated that black women earned more bachelor's degrees in science than black men but only a third as many bachelor's degrees in engineering.

The Task Force study also indicated that the picture is similar for Hispanics. Hispanics are America's fastest growing minority group, comprising nine percent of the population. Only 2 percent of Hispanics, however, are scientists and engineers. They hold 3 percent of all bachelor's degrees and 2 percent of all Ph.Ds in science and engineering. Hispanic women earn slightly fewer bachelor's degrees in science than Hispanic men but only one-sixth as many bachelor's degrees in engineering.

Another group studied in this report was white women. While they make up only 10 percent of all employed scientists and engineers, they are 43 percent of the U.S. population. In 1989, white women earned 22 percent of all bachelor's degrees but only 13 percent of the Ph.Ds in engineering. They are more likely than males to be enrolled in the life sciences at the undergraduate level, and eight times more likely to be in life sciences at the graduate level. While increasing numbers of white women are entering careers in science and engineering, they do not seem to be choosing these careers in the same proportions as other professional areas.

Czujko and Bernstein (1989), in a report about high school student enrollment in mathematics and science courses, reported the following findings:

Physics and Chemistry

- Most high school seniors (60%) have taken neither physics nor chemistry. Dramatic attrition occurs very early in the mathematics course sequence for students who do not take physics or chemistry.

- Among high school seniors, those who take physics have the highest achievement test scores in mathematics, reading, and vocabulary. Physics students are also the most involved in extra-curricular activities.

- An educational process starting with mastering basic skills and enrolling in an academic curriculum will most likely result in students taking physics and chemistry as well as aspiring to graduate from a four-year college.

- Less than one-third of the women in a high school chemistry class take physics, while over half of the men do so.

- Nearly 60 percent of the students who take high school chemistry, but not physics, are female.

- Students who anticipate majoring in education during college are the least likely of any other surveyed major to have taken a high school course in physics or chemistry. Students who intend to major in the health sciences and social sciences are predominantly female and are most likely to have taken chemistry but not physics in high school.

- Students who anticipate majoring in engineering or the physical sciences during college are overwhelmingly male and are the most likely to have completed physics in high school.

Race and Ethnic Background

- Among students with poor reading skills, blacks and Hispanics are more likely than Asians or whites to have problems with mathematics.

- Among students with strong reading skills, Asians and whites are more likely than blacks or Hispanics to have strong mathematics skills.

- Eighty-four percent of black students and 78 percent of Hispanic students score lower on mathematics achievement tests than average white students.

- Among students with exceptional mathematics achievement test scores, black students are more likely than students from any other racial group to take both physics and chemistry.

- Black students have high postsecondary school expectations, but proportionally few are enrolled in college preparatory programs.

- Among seniors with above average mathematics achievement test scores, Hispanics are the least likely to be enrolled in a college preparatory program.

THE GENDER GAP IN MATHEMATICS AND SCIENCE

- Females score lower than males on tests of mathematics achievement.

- Females and males are equally likely to take Algebra I, but males are somewhat more likely to take geometry, Algebra II, and chemistry. In trigonometry and calculus, males outnumber females by 3 to 2.

- Male and female students who score equally well on the mathematics achievement test are equally likely to take chemistry and trigonometry. But females of high mathematics aptitude are somewhat less likely than males of similar aptitude to take calculus.

- Significantly fewer female students with exceptional achievement test scores in mathematics take physics compared to their male classmates with identical test scores. There appear to be unique barriers keeping females out of physics classes.

- Even though women are participating in the labor force and in higher education in record numbers, they are still heavily drawn into female-dominated careers and infrequently move into traditionally male careers.

- Neither differences in mathematics achievement nor differences in mathematics and science coursework can account for the overwhelming gender-related differences in educational and occupational goals.

- In many ways, the aspirations of high-achieving females resemble low achievers more than they do the aspirations of high achieving males.

In 1986, Dossey et. al. reported that only about half of 17-year-old students reached a proficiency associated with material taught in junior high school mathematics. Neuschatz and Covalt (1988) found that only 20 percent of the senior class of 1987 had taken high school physics. Snyder (1987) reported that the high school graduation rates for blacks had increased, but the rate at which these black graduates were attending college had gone down.

Consequently, fewer blacks were enrolled in institutions of higher education in 1985 than there were in 1975. Finally, Czujko and Bernstein noted that there was little evidence that women, even those with exceptional mathematics ability, are taking much more junior and senior level coursework in mathematics and science than those women who graduated in 1980.

The Mathematical Sciences Education Board (MSEB), a consortium of the National Academy of Sciences, the National Academy of Engineering, the Institute of Medicine, and the National Research Council, held a national convocation in 1990 in Washington, D. C. Out of this convocation came the report Making Mathematics Work for Minorities: Framework for a National Action Plan, 1990-2000. This report reflected two major commitments by the National Academy of Sciences and the National Academy of Engineering: "a commitment to all our youth, especially in mathematics and science, and a commitment to make mathematics and the sciences available to the underrepresented groups in our country to ensure the total education of all our citizens" (p. 2).

A quote from the MSEB report illustrates the urgency of the issue:

> Mathematics is important not just in the education of scientists, engineers, and economists but also in the education of every working citizen in the United States. It's hard to see how anybody can pull down anything better than a minimum wage job in the years ahead without quantitative skills. The world is changing, with an increasing emphasis on science and technology in every aspect of life: the service sector, the manufacturing sector, and so forth. Consequently, quantitative skills are prerequisites to enjoying a decent standard of living.
>
> This, of course, has special significance for women and minorities, groups that have traditionally been shut out of many technical jobs and careers because of weak mathematics preparation. Increasingly, these groups will be shut out of just about any job in the years ahead without an adequate basis: a foundation in mathematics (p. 2).

FINDINGS: STATUS OF BLACK, HISPANIC, AND FEMALE PARTICIPATION AND ACHIEVEMENT IN MATHEMATICS, SCIENCE, AND TECHNOLOGY IN VIRGINIA'S SECONDARY SCHOOLS

"A self fulfilling prophecy has been created and nurtured which asserts that minorities and women can't do mathematics and, therefore, that we should not expect much from these groups. Low expectations produce low achievement, and low achievement, in turn, tends to serve as a justification for low expectations, which produces a continuous, vicious cycle." (Making Mathematics Work for Minorities: Framework for National Action)

This statement, made by J. Arthur Jones, President, Futura Technologies, and Steering Committee Chair of the Mathematical Sciences Education Board's National Convocation, can be equally applied to science (especially the advanced physical sciences) and advanced technologies. The education phenomenon described, with its consequences for student success, has been well documented in national studies and deserves very close scrutiny in the Commonwealth to assure that educational opportunities and expectations are equal for all students.

PARTICIPATION OF BLACK, HISPANIC, AND FEMALE STUDENTS IN MATHEMATICS, SCIENCE, AND TECHNOLOGY

National studies have found that black, Hispanic, and female students often do not pursue the most advanced mathematics, science, and technology courses at the same level of participation as the total population of students or at the same level as white students (Oakes, 1990, Czujko and Bernstein 1990). This section of the study documents the status of the participation of Virginia's black, Hispanic, and female secondary students in mathematics, science, and technology courses. The level of participation of blacks and Hispanics is compared to that of white students and to the enrollment percentage of each ethnic group in the study sample. The enrollment of female students is compared to the total female percentage of the sample and to the percentage of enrollment of male students in the same courses.

Black and Hispanic Student Enrollment in Science

This section of the report first examines the total percentage of enrollment in applied, academic, and advanced academic courses by ethnic group. Secondly, the percentage of enrollment for each ethnic group in each course level (applied, academic, and advanced academic) is presented in individual graphs. These individual ethnic group graphs are presented to detail enrollment differences by course level for direct comparison within the ethnic group.

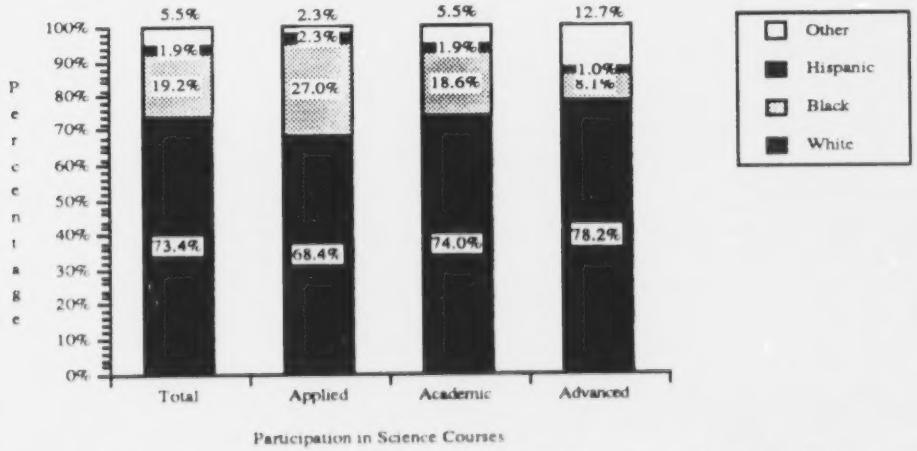


Figure 1: Comparison of Enrollment for White, Black and Hispanic Science Students by Course Level

The purpose of Figure 1 is to provide an aggregate view of the enrollment data for this section. The graph shows that when the percentage of students of each ethnic group in the total science sample was compared to percentages of students enrolled in applied/general, academic, and advanced academic science courses by ethnicity, the black and Hispanic student percentages of applied/general course enrollment was higher than the percentages of black and Hispanics students in the sample. Also, the percentage of black and Hispanic students enrolled in academic and advanced academic science courses is less than the percentages of the sample for each of these groups. For white students in the sample, enrollment in applied/general courses was less than the percentage of the sample while enrollment in academic and advanced academic science courses was greater than the white student percentage of the total sample. An examination of enrollment data for each individual group studied follows.

As indicated in Figure 2, black students were 19.2 percent of all students in the sample, 27 percent of the students enrolled in applied/general science courses, 18.6 percent of those taking academic courses, and 8.1 percent of all students taking advanced academic science courses were black.

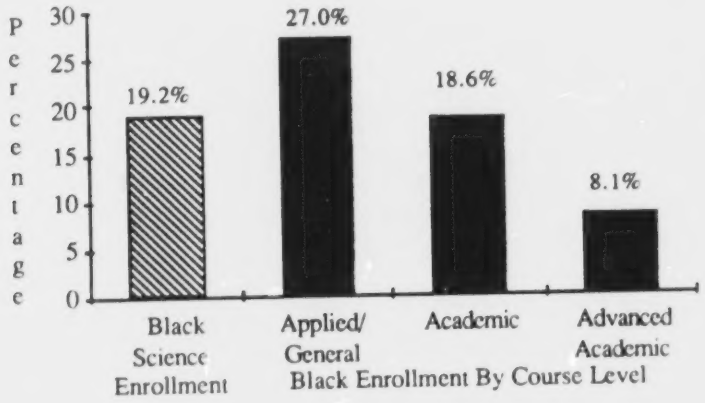


Figure 2: Comparison of Percentage of Black Students Enrolled in Science Courses by Course Level to Percentage of Black Students Enrolled in Science

Hispanic students constituted 1.9 percent of all students in the sample, 2.3 percent of the students enrolled in applied/general science courses, 1.9 percent of those taking academic courses, and 1.0 percent of all students taking advanced academic science courses. (Figure 3)

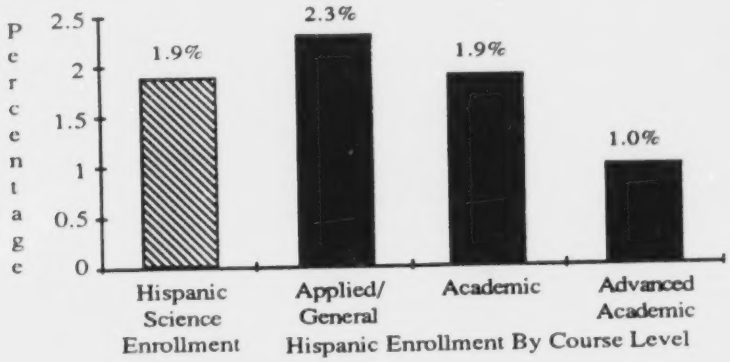


Figure 3: Comparison of Percentage of Hispanic Students Enrolled in Science Courses by Course Level to Percentage of Hispanic Students Enrolled in Science

White students comprised 73.4 percent of all students in the sample, 68.4 percent of the students enrolled in applied/general science courses, 74.0 percent of those taking academic courses and 78.2 percent of all students taking advanced academic science courses. (Figure 4)

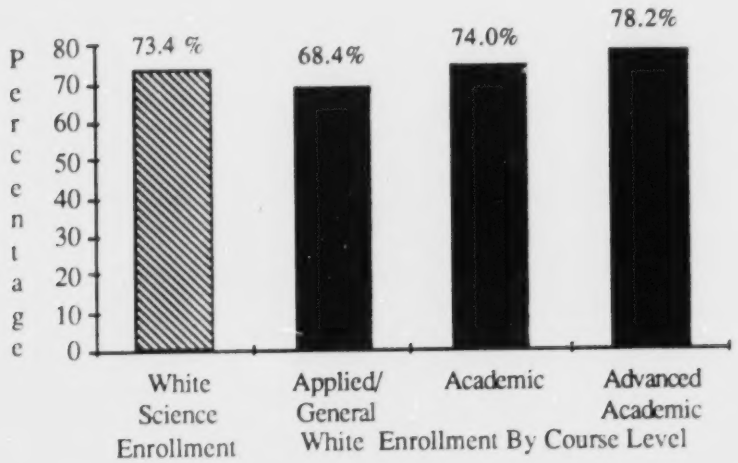
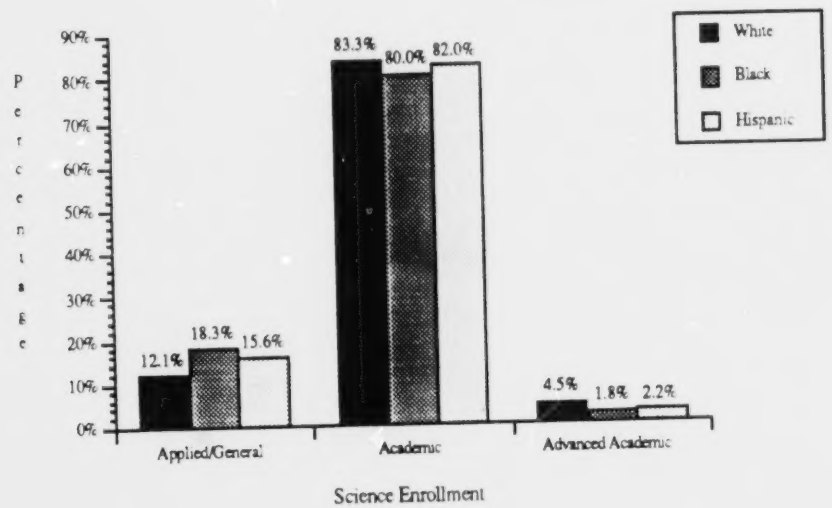


Figure 4: Comparison of Percentage of White Students Enrolled in Science Courses by Course level to Percentage of White Students Enrolled in Science

The data depicted in Figures 2, 3, and 4 further illustrate that black and Hispanic students were overrepresented as enrolles in the applied/general science courses, and under-represented in the advanced academic science courses when compared with black and Hispanic enrollment percentages for the total student sample. Conversely, white students were enrolled in applied/general courses at a lower percentage than the white percentage of the total sample, and were represented in advanced academic courses at a greater percentage than the white percentage of the total sample.

The following data summarize the distribution of science students in applied/general, academic, and advanced academic science courses by ethnic group to emphasize the enrollment comparison among ethnic groups.

Examining the enrollment data for the percentage of students of each ethnic group enrolled in each level of science course revealed the following information, illustrated in Figure 5. Of all white students in the sample, 12.1 percent were enrolled in applied/general courses; 15.6 percent of Hispanic students, and 18.3 percent of all black science students were enrolled in applied/ general courses. While 83.3 percent of all white science students were enrolled in academic courses, 82 percent of Hispanic students, and 80 percent of black students were enrolled. While 4.5 percent of all white science students were enrolled in advanced academic courses, 2.2 percent of Hispanic and 1.8 percent of black students were enrolled in the same courses.



Note: All differences between the enrollment of black and white students, and between the enrollment of Hispanic and white students were evaluated for significance at the 0.01 level.

Figure 5: Comparison of the Percentages of Black, White and Hispanic Students Enrolled in Applied/General, Academic, and Advanced Academic Science Courses

The percentage of black students enrolled in applied science courses was high and the percentage enrolled in advanced academic courses was low compared to similar enrollment percentages for white students. Hispanic student enrollment in science courses showed a similar trend.

There was a small but significant difference in the percentage of enrollment of black, and white students in academic courses (3.3 percentage points), while the small difference in white and Hispanic enrollment (2.0 percentage points) was not significant. However, the enrollment of white students exceeded that of black and Hispanic students for each comparison (Figure 5). These data suggest that black and Hispanic students are not pursuing the advanced academic science courses which lead to entry into science and science related careers at a similar rate to that of white students.

Black and Hispanic Student Enrollment in Mathematics

This section of the report first examines the total percentage of enrollment in applied, academic, and advanced academic courses by ethnic group. Second, the percentage of enrollment for each ethnic group in each course level (applied, academic, and advanced academic) is presented in individual graphs. These individual ethnic group graphs are presented to detail enrollment differences and for direct comparison within the ethnic group.

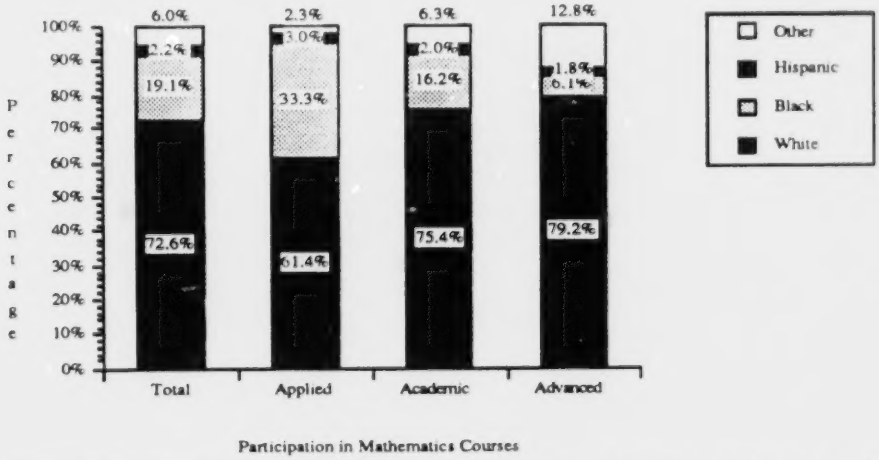


Figure 6: Comparison of Enrollment for White, Black, and Hispanic Mathematics Students by Course Level

The purpose of Figure 6 is to provide an aggregate view of the enrollment data for this section. The graph shows that when the percentage of students of each ethnic group in the total mathematics sample was compared to percentages of students enrolled in applied/general, academic, and advanced academic mathematics courses by ethnicity, the black and Hispanic student percentages of applied/general course enrollment was higher than the percentages of black and Hispanics students in the sample.

Also, the percentage of black and Hispanic students enrolled in academic and advanced academic mathematics courses is less than the percentages of the sample for each of these groups. For white students in the sample, enrollment in applied/general courses was less than the percentage of the sample while enrollment in academic and advanced academic mathematics courses was greater than the white student percentage of the total sample. An examination of enrollment data for each individual ethnic group follows.

While black students were 19.1 percent of all mathematics students in the sample, they were 33.3 percent of the students enrolled in applied/general mathematics courses, 16.2 percent of those taking academic courses, and 6.1 percent of all students taking advanced academic mathematics courses were black (Figure 7).

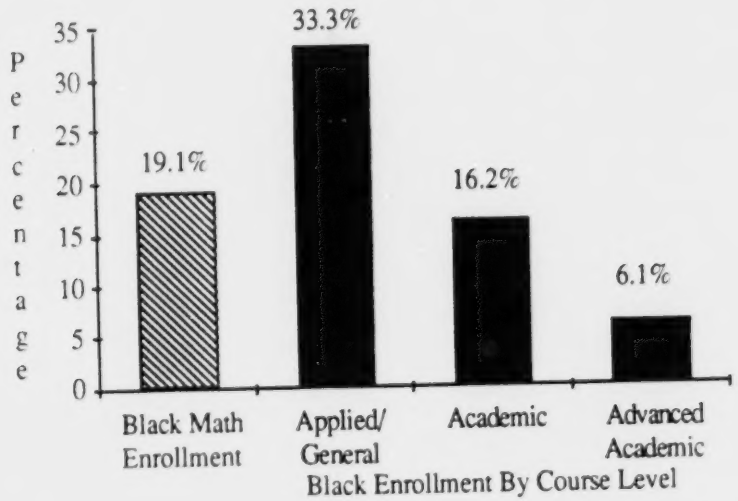


Figure 7: Comparison of Percentage of Black Students Enrolled in Mathematics Courses by Course Level to Percentage of Black Students Enrolled in Mathematics

As demonstrated in Figure 8, Hispanic students were 2.2 percent of all mathematics students in the sample, 3.0 percent of the students enrolled in applied/general mathematics courses, 2.0 percent of students taking academic courses, and 1.8 percent of all students taking advanced academic mathematics courses were Hispanic.

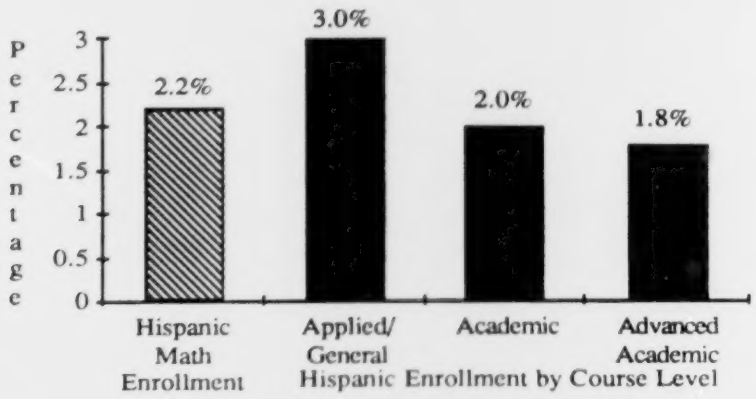


Figure 8 : Comparison of Percentage of Hispanic Students Enrolled in Mathematics Courses by Course Level to Percentage of Hispanic Students Enrolled in Mathematics

White students were 72.6 percent of all mathematics students in the sample, 61.4 percent of the students enrolled in applied/general mathematics courses, 75.4 percent of those students taking academic courses, and 79.2 percent of all students taking advanced academic mathematics courses were white (Figure 9).

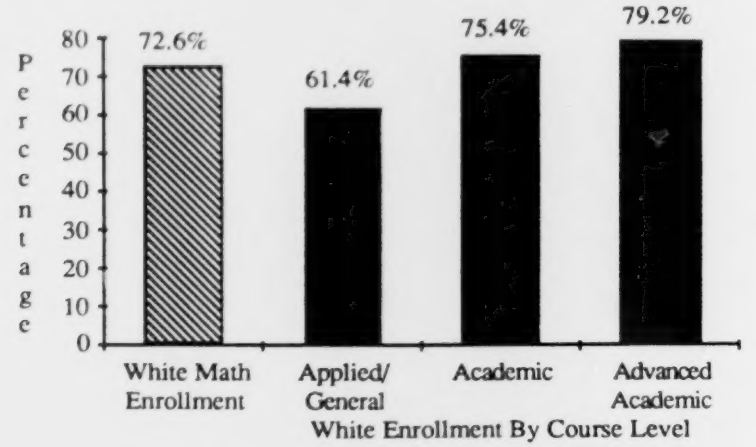
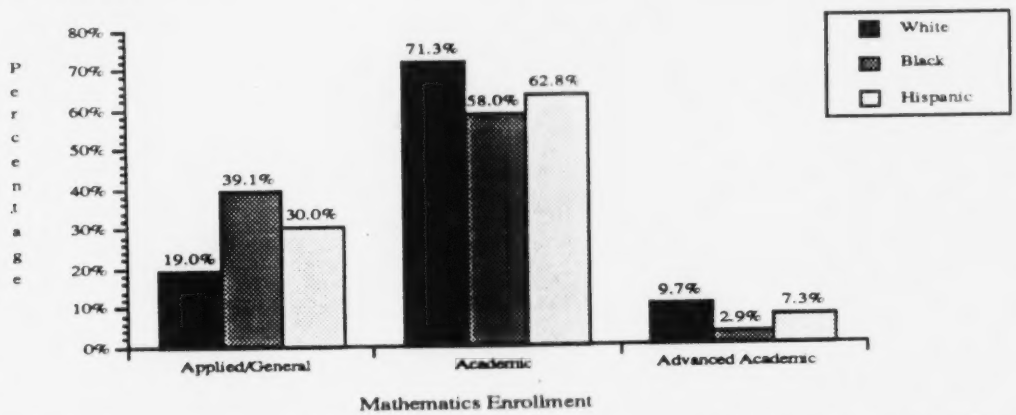


Figure 9: Comparison of Percentage of White Students Enrolled in Mathematics Courses by Course Level to Percentage of White Students Enrolled in Mathematics

The data depicted in Figures 7, 8, and 9 further illustrate that black and Hispanic students were overrepresented in the applied/general mathematics courses and underrepresented in the advanced academic mathematics courses compared to the black and Hispanic percentages of the student sample. White students were enrolled in applied/general courses at a percentage less than their percentage of the total sample, and enrolled in advanced academic courses at a percentage greater than the white percentage of the total sample. While the differences in enrollment percentages are significant for both blacks and Hispanics compared to whites, the magnitude of the differences is greater for black than for Hispanic students.

The following data summarize the distribution of mathematics students in applied/general, academic, and advanced academic mathematics courses by ethnic group to emphasize the enrollment comparison among ethnic groups.

Examining the enrollment data for the percentage of students of each ethnic group enrolled in each level of mathematics course revealed the following information, illustrated in Figure 10. Of all white students in the mathematics sample, 19.1 percent were enrolled in applied/general courses; 30.0 percent of Hispanic students, and 39.1 percent of all black mathematics students were enrolled in applied/ general courses. While 71.3 percent of all white mathematics students were enrolled in academic courses, 62.8 percent of Hispanic students, and 58.0 percent of black students were enrolled. While 9.7 percent of all white mathematics students were enrolled in advanced academic courses, 7.3 percent of Hispanic and 2.9 percent of black students were enrolled in the same courses.



Note: All differences between the enrollment of black and white students, and between the enrollment of Hispanic and white students were evaluated for significance at the 0.01 level.

Figure 10: Comparison of the Percentages of Black, White and Hispanic Students Enrolled in Applied/General, Academic, and Advanced Academic Mathematics Courses

A significantly greater percentage of black and Hispanic students than white students were enrolled in applied/general mathematics courses. A significantly smaller percentage of black and Hispanic students than white students were enrolled in academic and advanced academic mathematics courses. These data suggest that black and Hispanic students are not taking mathematics courses which lead to careers based in mathematics at a rate similar to that of white students in Virginia secondary schools.

Black, Hispanic, and White Student Enrollment in Technology Courses

This section of the report first examines the total percentage of enrollment in the several technology programs offered in Virginia secondary schools by ethnic group (Figure 11). Next, the percentage of enrollment for each ethnic group in each program is presented in individual graphs. These individual ethnic group graphs are presented to detail enrollment differences and for direct comparison within the ethnic group.

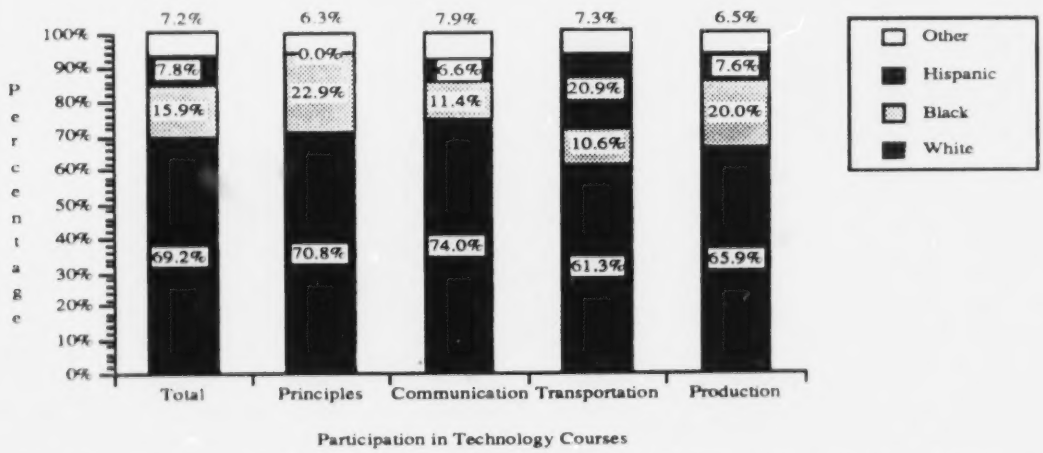


Figure 11: Comparison of Percentage of Enrollment for White, Black, and Hispanic Technology Students by Program

The purpose of this graph is to provide an aggregate view of the enrollment data for this section. The graph shows that black enrollment was greatest in "Principles of Technology", and applied physics program. Hispanic enrollment was greatest in the transportation program, while white student enrollment was greatest in "Principles of Technology" and the communications program. An examination of enrollment data for each individual ethnic group follows.

While black students were 15.9 percent of all students in the sample, they were 22.9 percent of students enrolled in principles of technology courses, 11.4 percent of those enrolled in communication courses, 10.6 percent of those enrolled in transportation courses, and 20.0 percent of those enrolled in production courses (Figure 12).

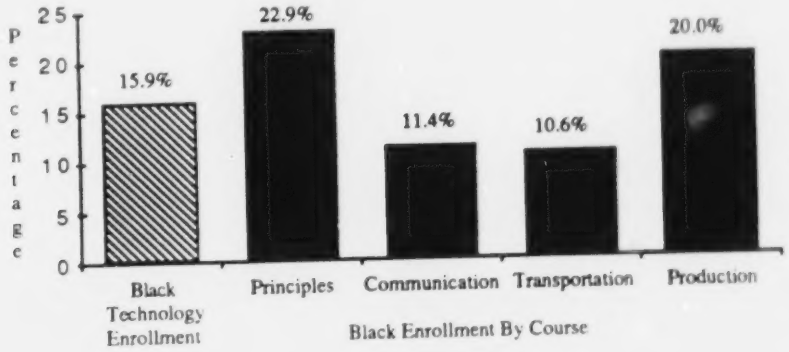


Figure 12: Comparison of Percentage of Black Students Enrolled in Technology Programs to Percentage of Black Students Enrolled in all Technology Programs

By comparison, white students were 69.2 percent of the sample, 70.8 percent of those enrolled in principles of technology courses, 74.0 percent of those enrolled in communication courses, 65.9 percent of those enrolled in transportation courses, and 61.3 percent of those enrolled in production courses (Figure 13).

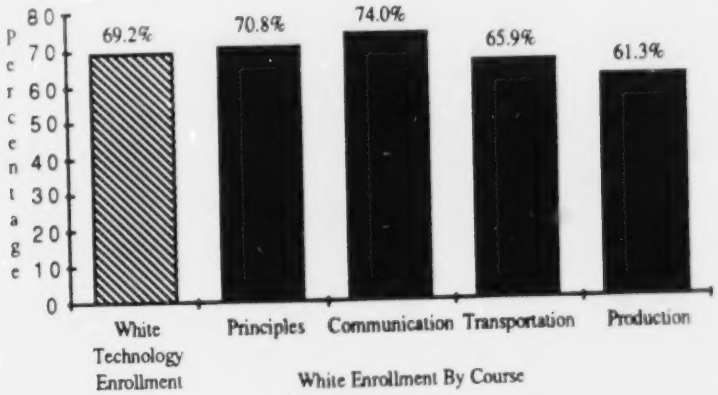


Figure 13: Comparison of White Students Enrolled in Technology Programs to Percentage of White Students Enrolled in all Technology Programs

Hispanic students represent 7.8 percent of the sample. There were no Hispanic students enrolled in principles of technology courses; 6.6 percent of communications students, 20.9 percent of transportation students, and 7.6 percent of production students were Hispanic (Figure 14).

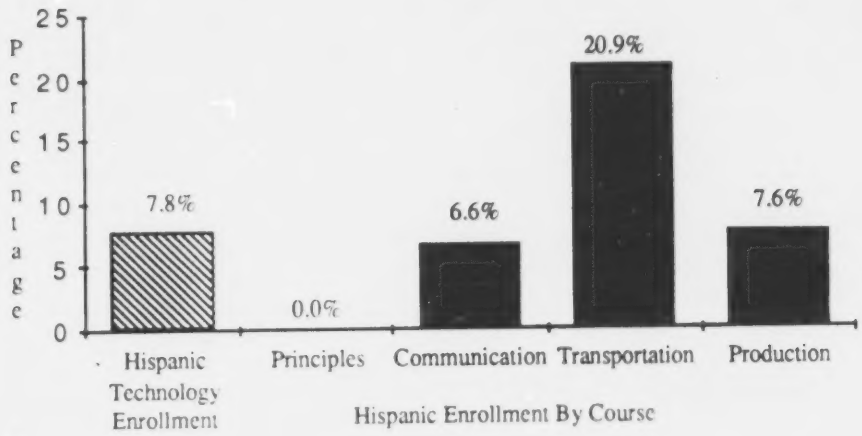


Figure 14: Comparison of Percentage of Hispanic Students Enrolled in Technology Programs to Percentage of Hispanic Students Enrolled in all Technology Programs

These data indicate that black students are enrolling in one of the more challenging technology courses, Principles of Technology (22.9%), but are not enrolling in communications (11.4%) and transportation programs (10.6%) at the same level as the percentage of black students taking technology courses (15.9%). Black students are overrepresented in the less challenging production program (20%) as compared to the percentage of black students in technology programs. Similarly, Hispanic students are underrepresented in the Principles of Technology program (0%), and overrepresented in the transportation (20.9%) program compared to Hispanic percentage of the sample (7.8%). White technology students are overrepresented in the communication program (74%) and underrepresented in production (61.3%) and transportation (65.9%) courses compared to white student percentage of all technology students (69.2%).

The extensive variability in student choice of technology programs gives no basis for generalizations regarding program choices by ethnicity.

ENROLLMENT OF FEMALE STUDENTS IN MATHEMATICS, SCIENCE, AND TECHNOLOGY

National studies have revealed that female students enroll in advanced mathematics, science, and technology courses to a lesser extent than would be indicated by their percentage of the student population. This section of the study examines the enrollment of Virginia female students in these disciplines as compared to the female percentage of the samples examined and compared to the percentage of male enrollment in the same courses (Czujko and Bernstein, 1990).

ENROLLMENT OF FEMALE STUDENTS IN SCIENCE COURSES

Female students comprised 49.6 percent of the sample of secondary school science students surveyed for this study. Female students represented 44.2 percent of students enrolled in applied/general science courses, 50.2 percent of students enrolled in academic courses, and 53.0 percent of students enrolled in advanced academic courses (Figure 15).

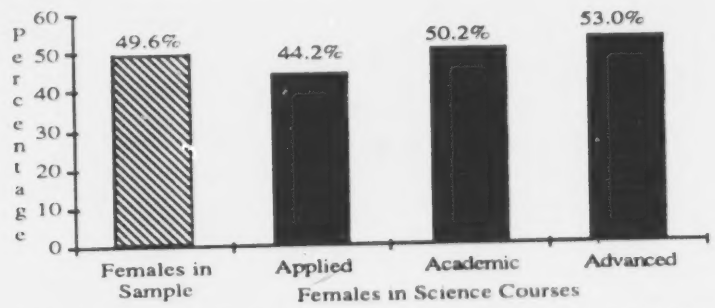


Figure 15: Comparison of Percentage of Female Students Enrolled in Science Courses by Course Level to Percentage of Total Female Students Enrolled in Science

Of all female students in the science sample, 11.6 percent were enrolled in applied/general science courses, 83.8 percent were enrolled in academic courses, and 5.4 percent were enrolled in advanced academic courses. For comparison, 14.4 percent of male students were enrolled in applied/general courses, 81.6 percent in academic courses, and 4.0 percent in advanced academic courses. All of these differences between male and female enrollments were established as significant at the 0.01 level.

Black female students comprised 10 percent of all students in the sample and 5 percent of students taking advanced academic science courses. Hispanic female students were 0.9 percent of all science students and 0.05 percent of those taking advanced science courses.

These data demonstrate that female student science enrollment exceeds that of male students in both academic and advanced academic science courses. However, for minority female students, enrollment in advanced science courses was greater than minority male students but approximately one-half the minority female representation in the sample.

ENROLLMENT OF FEMALE STUDENTS IN MATHEMATICS COURSES

Female students comprised 49.6 percent of the sample of secondary school mathematics students surveyed for this study. Applied/general mathematics courses had 45.7 percent female enrollment, academic mathematics courses had 51.1 percent female enrollment, and advanced academic mathematics courses had 47.4 percent female enrollment (Figure 16).

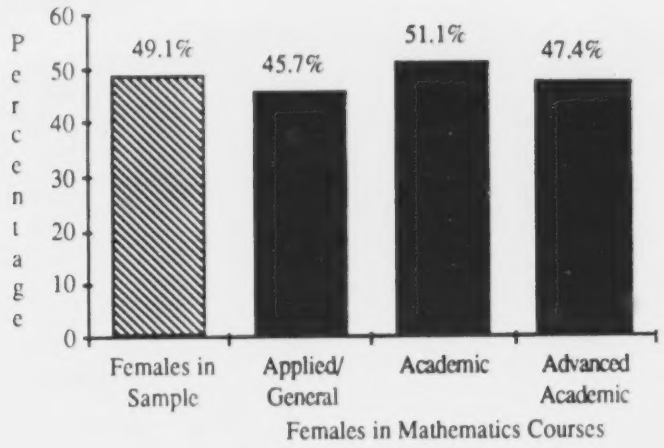


Figure 16: Comparison of Percentage of Female Students Enrolled in Mathematics Courses by Course Level to Percentage of Total Female Students Enrolled in Mathematics

Of all female students in the mathematics sample, 20.7 percent were enrolled in applied/general mathematics courses, 70.8 percent were enrolled in academic courses, and 8.6 percent were enrolled in advanced academic courses. For comparison, 24.1 percent of male students were enrolled in applied/general courses, 66.5 percent in academic, and 9.3 percent in advanced academic mathematics courses. All of these differences between male and female enrollments were established as significant at the 0.01 level.

Black female students represent 10 percent of all students in the sample of mathematics students and 3 percent of students taking advanced academic mathematics courses. Hispanic female students comprise 0.9 percent of all mathematics students, and 0.9 percent of the enrollment in advanced mathematics courses.

These data show that white and black female student enrollment in advanced academic mathematics courses is less than their percentage of the total sample, while Hispanic female students were enrolled in advanced mathematics courses at the same percentage as their percentage of the sample.

FEMALE ENROLLMENT IN TECHNOLOGY EDUCATION

Of the total enrollment in the technology education course sample, 14.0 percent were female. By comparison, females represented 27.1 percent of students enrolled in principles of technology courses, 17.1 percent of students enrolled in communication courses, 2.5 percent of students enrolled in transportation courses, and 12.5 percent of students enrolled in production courses (Figure 17).

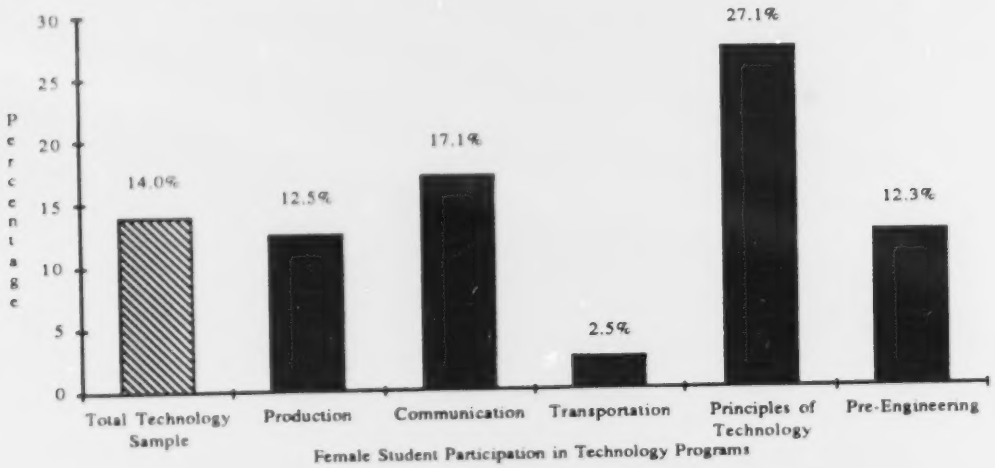


Figure 17: Comparison of Percentage of Female Students Enrolled in Technology Courses by Course Level to Percentage of Total Female Students Enrolled in Technology

The data illustrated in Figure 17 demonstrate that female students were not enrolled in any of the technology areas at percentages reflecting female percentage of the total student population (50.9%). The most academically advanced of these courses, pre-engineering, was male dominated with 87.7 percent of the total enrollment.

SUMMARY

Academic and advanced academic mathematics, science, and technology courses are designed to prepare students post-secondary education or technical vocational areas upon graduation. As such, students who successfully complete these courses are provided a career and employment advantage over those who do not.

White students were enrolled in academic and advanced academic mathematics, science, and technology courses at percentages greater than the percentages of black or Hispanic enrollment in the same courses. In all cases reviewed for this study, white, Hispanic, and black enrollment percentages in advanced academic courses occurred in that descending order. Although all advanced academic course enrollment differences cited are statistically significant, the greater magnitude of the differences between black and white percentages of enrollment in advanced academic mathematics and science courses enhances the importance of these comparisons for strategic intervention to improve the participation of black students.

Applied/general mathematics and science courses are usually not rigorous and are designed as low-level, non-college preparatory courses. White students were enrolled in applied/general mathematics and science courses at a significantly lower percentage than black or Hispanic students. These findings suggest that black and Hispanic students, more often than white students, were enrolled in courses that do not develop the prerequisite skills necessary for enrollment in advanced academic mathematics and science courses.

Female student enrollment in advanced academic science courses was greater than female representation in the sample. However, female enrollment in advanced academic mathematics courses was significantly less than that of male students. Female student enrollment in all technology programs was significantly less than male enrollment. However, both the Principles of Technology program and the pre-engineering program are relatively new technology programs with small total enrollment and are not offered at many secondary schools.

ACHIEVEMENT OF BLACK, HISPANIC, AND FEMALE STUDENTS IN MATHEMATICS, SCIENCE, AND TECHNOLOGY

This section of the report describes the achievement of mathematics, science, and technology students in Virginia secondary schools compared by ethnicity and gender. Several sources of data, including the following, were examined to accomplish the comparisons.

- Types of diplomas received by 1990 Virginia graduates compared by gender and ethnicity
- Aggregate Virginia State Assessment Program (VSAP) scores for mathematics and science
- Student achievement on the National Assessment of Educational Progress
- Student participation in the Virginia Junior Academy of Science
- Enrollment in the five Virginia Magnet Schools for Mathematics, Science, and Technology
- Examination of the advanced course enrollment of student participants in the National Science Scholars Program for 1991 by gender and ethnicity.

Enrollment in the Magnet Schools for Science and Technology, participation the Virginia Junior Academy of Science competitions, and participation in the National Science Scholars Program are used in this study as indicators of achievement because participation in each is recognition of a high level of achievement in mathematics, science, or technology.

Types of Diplomas Received by Gender and Ethnicity

A review of diplomas received by 1990 Virginia graduates by ethnicity indicates that a lower percentage of black students received advanced studies diplomas (23%) than the Virginia average percentage of Hispanic students. Hispanic students received advanced studies diplomas at a similar percentage (38%) to that for the average of all Virginia students (39%), Figure 18.

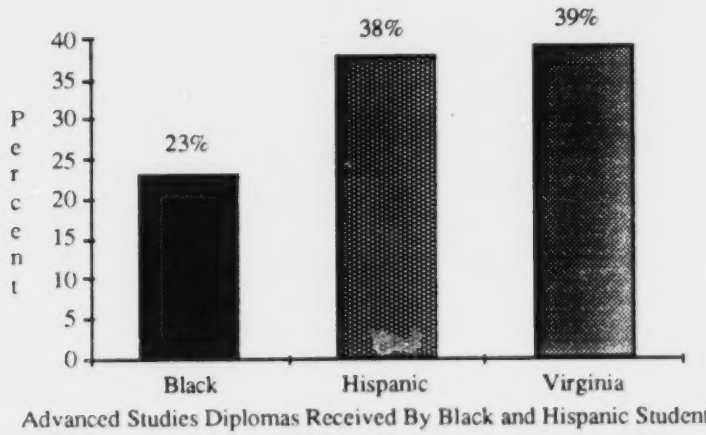


Figure 18: Comparison of Diplomas Received by Black and Hispanic Students to Virginia Average of Advanced Studies Diplomas Received (1990)

A review of the gender (Figure 19) distribution indicates that female students earned more advanced studies diplomas (57%) than male students (43%).

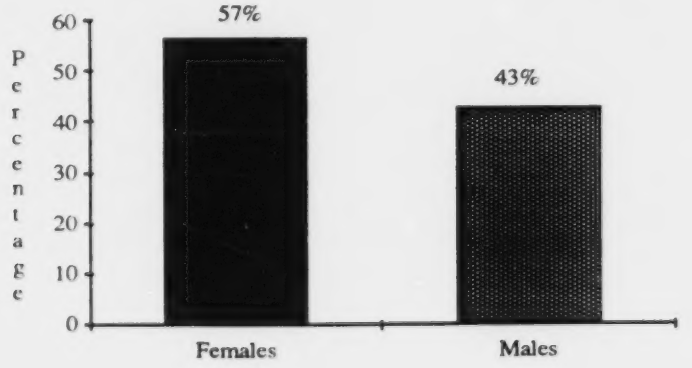


Figure 19: Percentage of Students Receiving Advanced Studies Diplomas by Gender (1990)

Virginia State Assessment Program (VSAP) Mathematics and Science Scores (1991)

The Virginia State Assessment Program is administered annually to Virginia's fourth-, eighth,- and eleventh-grade students. Data from the 1990-91 assessment provides the following look at mathematics and science achievement by gender and ethnicity.

Figures 20 and 21 show that black and Hispanic students scored lower than white students on the VSAP mathematics and science tests at all grade levels tested.

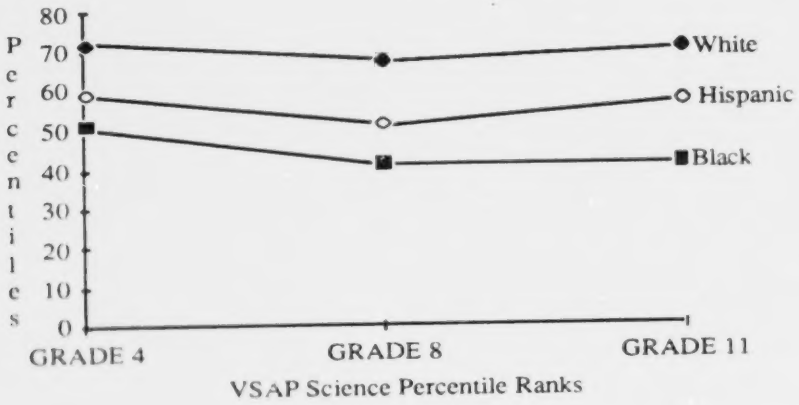


Figure 20: Average VSAP Science Scores for Fourth-, Eighth-, and Eleventh-Grade Virginia Students (1990-91)

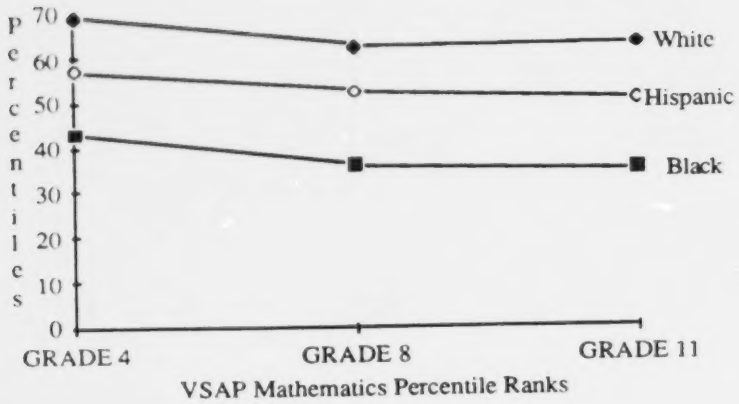


Figure 21: Average VSAP Mathematics Scores for Fourth-, Eighth-, and Eleventh-Grade Virginia Students (1990-91)

These graphs are presented to show the trend of achievement at several grade levels as well as the ethnic achievement comparisons for secondary students. Figure 22 shows that the average female achievement in mathematics is identical to that of male students. Figure 23, however, shows a 10 percentile point difference in achievement scores on the science VSAP subtest at eleventh grade, with male students scoring at 70 percentile and female students scoring at 60 percentile.

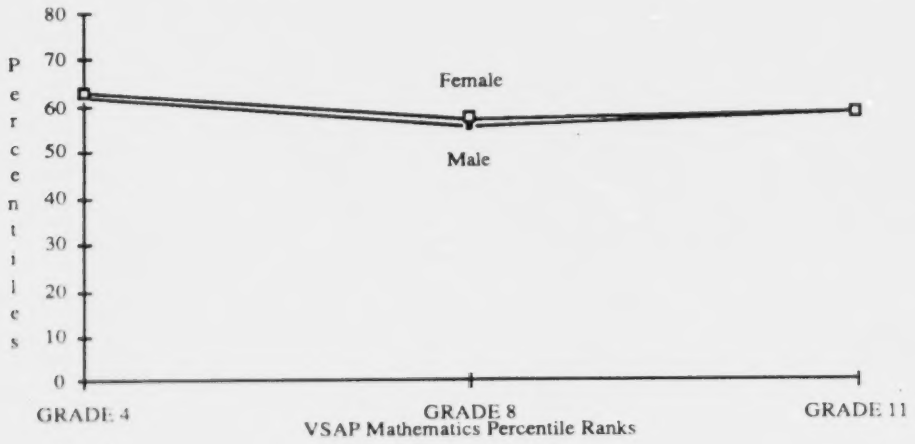


Figure 22: Average VSAP Mathematics Scores by Gender for Fourth-, Eighth-, and Eleventh-Grade Virginia Students (1990-91)

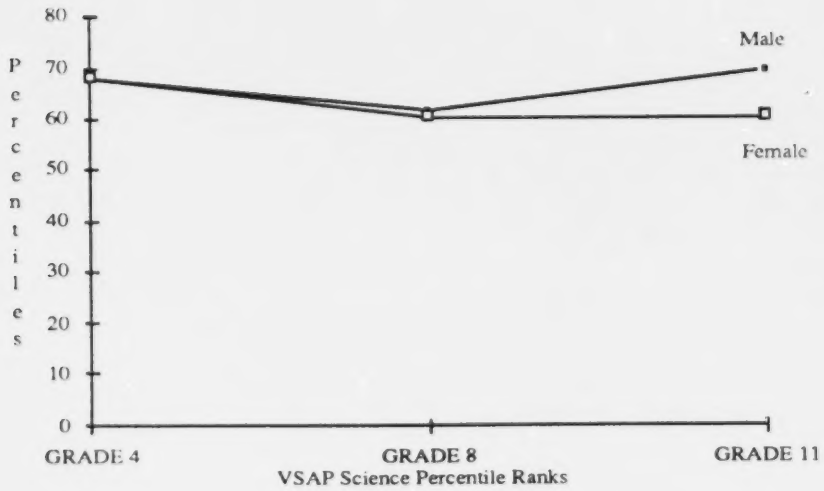


Figure 23: Average VSAP Science Scores by Gender for Fourth-, Eighth-, and Eleventh-Grade Virginia Students (1990-91)

Student Achievement on the National Assessment of Educational Progress

The summary report of the first nationwide state-by-state assessment of the mathematics achievement of eighth-grade students is of particular interest to the state of Virginia. This study was undertaken in 1990 by the National Assessment of Educational Progress (NAEP). For the first time, student achievement in Virginia was compared to the achievement of students in other states in the areas of mathematical skills and concepts. The Virginia data represent 104 public schools and 2,661 eighth-grade students. In its report, NAEP provided the percentage of eighth-grade students scoring at levels 200, 250, and 300 on a scale of 200-500 by race, ethnicity, and gender.

The following are the findings of the assessment related to black, Hispanic, and female student achievement:

- Two percent of black students and six percent of Hispanic students attained the highest proficiency level of 300 while 19 percent of white students attained the same level.

- Differences between the percentages of females (14%) and males (17%) in Virginia who achieved at level 300 on the NAEP assessment were not statistically significant.

Participation in the Virginia Junior Academy of Science by Gender

For 50 years, the Virginia Junior Academy of Science (VJAS) has provided opportunities for students of the Commonwealth to present original research in a refereed competition for recognition, awards, and scholarships. Student presenters are selected to participate in the annual VJAS competition on the basis of initial readings of project papers by a panel of science educators and practicing scientists. Students judged to have the best papers in the categories of competition, up to a pre-determined limit for each category, are invited to present their papers at the annual VJAS competition. The 1991 group of 590 students was used to evaluate student participation by gender.

The percentage of male and female participants was determined for each competitive VJAS category and for the total of participants. These percentages were evaluated to compare male and female participation rates for each category. (Figure 24)

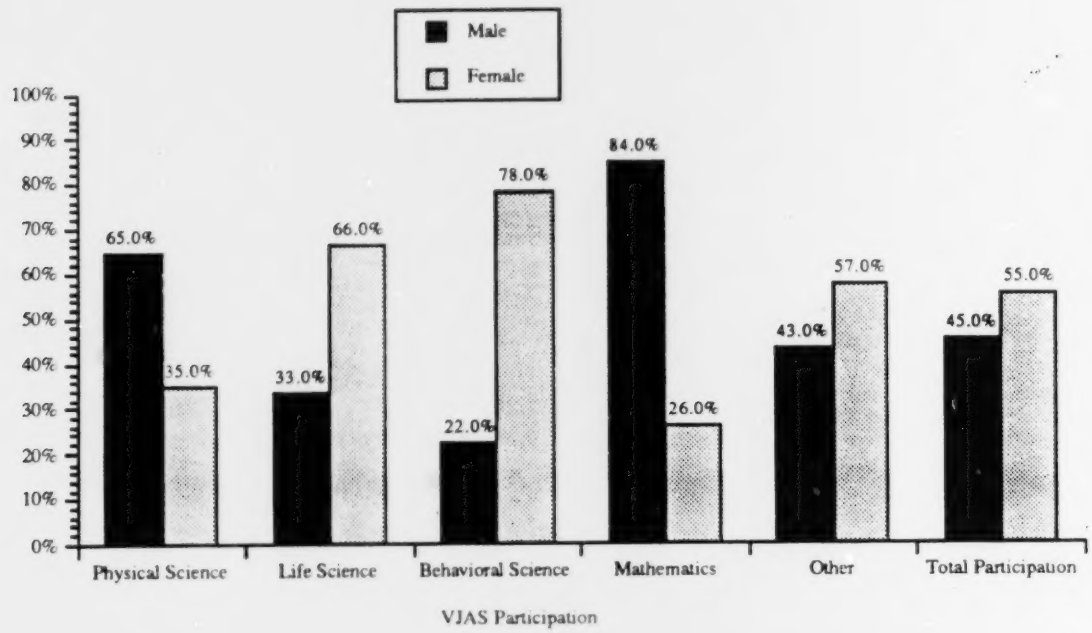


Figure 24: Comparison of 1991 VJAS Participation by Discipline and by Gender

While more female (55%) than male (45%) students participated in the VJAS 1991 competition, male students dominated the physical sciences categories (chemistry, physics and engineering) by almost a 2-to-1 margin, 65 percent to 35 percent. Female students dominated the life sciences (biology and genetics) to approximately the same degree, 67 percent to 33 percent.

Science and Technology Magnet School Enrollment by Ethnicity and Gender

Enrollment data (1991-2) for the five Virginia magnet schools for science and technology were examined and evaluated by gender and ethnicity as an indicator of achievement. Ethnic enrollment percentages were compared to the ethnic percentages of the state Student Enrollment Survey sample as an estimate of the representation by ethnic group. (Figure 25)

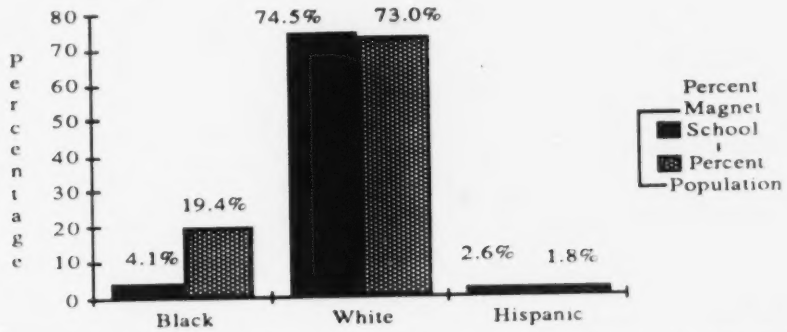


Figure 25: Comparison of the Percentage of Ethnic Student Enrollment in the Virginia Magnet Schools to the Percentage of Ethnic Enrollment in the VSAP Eleventh Grade Test Group, 1990-91.

Black students make up 4.1 percent of the 1991-92 magnet school enrollment, Hispanic students 2.6 percent, and white students 74.5% (1991-92 enrollment data). By comparison, black students comprised 19.4 percent of the eleventh grade students tested in VSAP, Hispanic students 1.8 percent and white students 73.0 percent. Female student enrollment in the magnet schools (42.2%) is 15.6 percentage points less than that of male students (57.8%).

These data reveal that black student enrollment in Virginia's magnet schools is approximately 15 percentage points less than the estimated black percentage of the Virginia secondary student population, using the eleventh-grade VSAP data as the estimate, while Hispanic and white magnet school enrollment percentages exceed the respective estimates of the total population percentages for each group. Female student enrollment is 8.6 percentage points less than female percentage of the population (50.8%), using the same population estimate, a significant difference. Black, Hispanic, and female students have a lower representation compared to white males in the current science and technology magnet school enrollment.

Student Participation in the National Science Scholars Program (1991)

In March 1991, the United States Department of Education began the implementation of the newly enacted National Science Scholars Program (NSSP) which was authorized under the "Excellence in Mathematics, Science, and Engineering Education Act of 1990 (P.L. 101-589)." The program authorizes the Department to award scholarships to outstanding high school seniors. Each year, two students are chosen by the federal Department from a list of four nominees from each congressional district in the participating states. At least two of the nominees from each state are to be female, and at least one of the two students chosen for the award by the President must be female.

The program's purpose is to recognize student excellence and achievement in the physical, life, and computer sciences, mathematics, and engineering by providing scholarships to meritorious graduating high school students to continue these studies at the post-secondary level.

During the period from April through June, 1991, the Virginia Department of Education made information available to school divisions about the requirements and purposes of the program. The Department distributed the application forms, assembled a nominating team, evaluated the student applications, and submitted its four nominations for each of the participating congressional districts to the federal Department of Education. There were no applicants from the Second Congressional District.

A detailed review of the demographic data from this self-selected, highly achieving sample of Virginia's twelfth-grade mathematics and science scholars indicated the following information:

- Of the 92 participants, 63 described themselves as white; 27 of these were female.
- Four black students participated in the program. All of these applicants were female.
- Ten Asian/Pacific Islanders participated in the program. Four of these were female.
- One American Indian female participated.
- There were no Hispanic student applicants.
- Fourteen students did not indicate race/ethnicity.
- Of the 92 applicants, 41 were female.

A detailed review of the transcript data included with each student's applications indicated specific information about the courses selected by these high-achieving students. The following information is presented on a gender basis.

- The 41 females took a total of 101 science courses above the Chemistry I level; 76 of these courses were in the physical sciences. This is an average of 2.5 high-level science courses per female student, 75% of which were physical sciences.

- The 51 males took a total of 102 science courses above the Chemistry I level: 82 of these were in the physical sciences. This is an average of 2.0 high-level science courses per male student, 80% of which were physical sciences.

- The 41 females took a total of 89 mathematics courses above the Algebra II/trigonometry level, an average of 2.2 high-level mathematics courses per female student.

- The 51 males took a total of 122 mathematics courses above the Algebra II/trigonometry level, an average of 2.4 high-level mathematics courses per male student.

- The 41 females took a total of 55 technology/ engineering/computer/science application courses, an average of 1.3 courses per female student.

- The 51 males took a total of 111 technology/ engineering/computer/science application courses, an average of 2.2 courses per male student.

The review of the demographic and course selection data for the high achieving students who participated in this scholarship program indicates several important points. Among these are;

- Black students comprised only about 5% of the applicants who identified their ethnicity. Further, there were no black male applicants.

- Females accounted for 45% of the total applicants. As a group,they had a higher average number (2.5) of upper level science courses than males (2.0), and took just a slightly smaller percentage of physical science courses than males. On the average, females took fewer upper level math courses (2.2) than males (2.4), although the difference is small. On the average, females took substantially fewer technology-engineering-computer courses (1.3) than males (2.2).

These data suggest that among the top secondary students, females and males participate and achieve at similar levels in science. Mathematics participation indicates a slight difference; however, technology courses show a substantial difference, with males enrolled in a higher number of courses.

Summary of all Indicators

Black students achieved at lower levels than did white students on all the measures used as indicators of achievement for this study. These measures included the following:

- Percentage of black students receiving advanced studies diplomas
- Scores on the VSAP assessments for all grade levels in mathematics and science
- Scores on the National Assessment of Educational Progress mathematics assessment
- Participation in the Virginia Magnet Schools for Science and Technology
- Participation in the National Scholars Program

Hispanic students achieved at lower levels than did white students on the following measures:

- Scores on the VSAP assessments for all grade levels in mathematics and science
- Scores on the National Assessment of Educational Progress mathematics assessment
- Participation in the Virginia Magnet Schools for Science and Technology
- Participation in the National Scholars Program

Hispanic students achieved at similar rates to white students on the following measure:

- Percentage of Hispanic students receiving advanced studies diplomas

Female Students achieved at lower levels than did male students on the following measures:

- Participation in the Virginia Junior Academy of Science Completion (1991), mathematics and physical science categories only
- Scores on the science section of the eleventh grade VSAP
- Participation in the Virginia Magnet Schools for Science and Technology

Female students achieved at levels equal to or exceeding that of male students on the following measures:

- Percentage of female students receiving advanced studies diplomas
- Scores on the VSAP assessments for all grade levels in mathematics and science, with the exception of eleventh grade science
- Scores on the National Assessment of Educational Progress mathematics assessment
- Participation in the Virginia Junior Academy of Science Competitions (1991) all categories but mathematics and physical science
- Participation in the National Scholars Program

FINDINGS: APPROACHES TO INCREASE ENROLLMENT OF BLACK, HISPANIC, AND FEMALE STUDENTS IN MATHEMATICS, SCIENCE, AND TECHNOLOGY

This section of the report presents strategies, activities, and programs that have proven successful in motivating students and developing their interest and achievement in mathematics, science, and technology. These strategies are intended to increase the level of interest and competence of black, Hispanic, and female students in mathematics, science,and technology. An additional objective is to increase the number of students who are literate in these disciplines and who are prepared to pursue advanced study in those topics.

- Develop teacher education strategies to help teachers develop skills necessary to meet the special needs of black, Hispanic, and female students.

- Develop extra-school instructional opportunities for minority and female students with interest and aptitude in mathematics, science, and technology, using the Governor's school programs as models.

- Establish systems to communicate to students and parents the availability of the extra-school, mentorship, and work-study programs in mathematics and science.

- Foster cooperative relationships between businesses involved in scientific and technological endeavors and local school divisions to provide work-study, mentorship, shadowing and scholarship programs for black, Hispanic, and female students.

- Develop opportunities for collaboration among teachers, counselors, parents, and school administrators in addressing the problem of increasing participation and achievement of minorities and females in the highly academic instructional areas of mathematics, science, and technology.

- Develop extra-school programs for minority and female students that use innovative, challenging instructional strategies and activities designed to improve interest and achievement in academic studies, modeled after the Governor's school programs.

- Expand the Governors' school concept to include programs for students who have exhibited potential but have not experienced exceptional achievement in academic mathematics, science, and technology studies.

- Develop programs for teacher academic studies for teachers' modeled on the strategies of the SCME (Southeastern Consortium for Minorities in Engineering) and EQUALS projects. These programs provide self-assessment opportunities and develop strategies to deal appropriately with the under-represented populations in academic mathematics and technology.

- Evaluate the prerequisites and student assignment criteria for advanced mathematics, science, and technology courses with the goal of eliminating any unnecessary barriers to the participation of minority and female students in these courses.

Special intervention programs to improve the participation and achievement of black, Hispanic, and female students in mathematics, science, and technology are important aspects of providing for equal educational opportunity. Believing that all students can learn and experience success in these important areas is critical if all facets of the formal and informal educational system are to help students overcome environmental barriers to success in academic pursuits.

Integrating Black, Hispanic and Female Initiatives into other Department of Education Initiatives

The current reform initiatives in which DOE is involved, such as V-QUEST, Common Core of Learning, Restructuring of K-12 Education, and the Xerox Project, should reflect the findings of this report in the DOE commitment to provide equal educational opportunity without regard to ethnicity or gender. The strategic plan for each of these initiatives should include methods of addressing the special needs of minority and female students.

The Department's *Common Core of Learning* and "restructuring" projects at the early childhood, pre-and early adolescent, and adolescent levels have the potential to diminish inequity in education practices for all Virginia students. Specific recommendations resulting from this study should be integrated into local school division curriculum efforts as they implement the Common Core initiative. This integration will help assure that the Common Core initiative, as implemented in local school divisions, will address the needs of all students.

In the Department's continuing efforts to restructure education, special consideration must be given to the issue of low enrollment of minorities, especially blacks and Hispanics, in academic and advanced academic courses. Close inspection of the data in this report reveals that female students, while generally participating in advanced academic programs at a rate which equals or exceeds that of male students, were not enrolled in the highest levels of mathematics, physical science, and technology courses to the same degree as were male students.

SUMMARY OF FINDINGS

The study team collected and examined data documenting student enrollment in mathematics, science, and technology courses by ethnicity and gender. In addition, data from several sources were evaluated which are direct or indirect functions of achievement. These data, which were studied as indicators of achievement, include the following.

Virginia Science Assessment Program (VSAP) scores
National Assessment of Educational Progress (NAEP) scores
Virginia Junior Academy of Science (VJAS) participation
Diplomas received by type
Virginia science and technology magnet school enrollment
National Science Scholars Program Participation

These data were also evaluated by gender and ethnicity. The findings generated through the evaluation of these data are summarized in this section.

FINDINGS

Black and Hispanic students were found to perform at a lower level than white students in both participation and achievement in mathematics and science, especially as participants in advanced courses. The difference in both participation and achievement was greater for black students than for Hispanic students. Female students participated and achieved on par with male students in most facets of mathematics and science studies. An exception occurs in advanced mathematics participation where the percentage of male students (52.6%) significantly exceeds that of female students (47.4%). Male students also had greater participation in Virginia Junior Academy of Science mathematics competition in which 85 percent of the participants were male. Other exceptions were noted in the participation of female students in VJAS physical science competitions, in which 65 percent of the competitors were male, and in magnet school enrollment, in which the female enrollment is 42.2 percent compared to 57.8 for males.

The enrollment of black (8%) and female (12.3%) students in the most advanced technology program, pre-engineering, was lower than the respective population percentages (approximately 20% and 50%).

Additional findings in this study are as follows:

- Of all white students in the science sample, 4.5 percent were enrolled in advanced academic courses, while 2.2 percent of Hispanic students and 1.8 percent of black science students were enrolled in advanced academic courses.

- Of all white students in the mathematics sample, 9.7 percent were enrolled in advanced academic courses, while 7.3 percent of Hispanic students and 2.9 percent of black mathematics students were enrolled in advanced academic courses.

- Of all female students in the science sample, 5.4 percent were enrolled in advanced academic courses, while 4.0 percent of male students were enrolled in advanced academic science courses.

- Of all female students in the mathematics sample, 8.6 percent were enrolled in advanced academic courses, while 9.3 percent of male students were enrolled in advanced academic mathematics courses.

- Black female enrollment in advanced science (5%) and mathematics courses (3%) was less than black female percentage of the mathematics and science samples (10%).

- Hispanic female enrollment in advanced science courses (0.05%) was approximately one-half the percentage of the sample 0.9%, while enrollment in advanced mathematics equaled the percentage of sample enrollment.

- Of the total enrollment in the technology education course sample, 14.0 percent were female and 86 percent male.

- The percentage of white students enrolled in advanced mathematics, science, and technology courses was significantly greater than the percentages of black or Hispanic students enrolled in the same courses.

- The performance of black students on the National Assessment of Educational Progress (NAEP) mathematics test was significantly lower than that of white participants. The performance of female students on the same assessment was not significantly lower than male students.

- Black student enrollment in Virginia's magnet schools (4.2%) is approximately 15 percentage points less than the percentage of black students in the Virginia student population (21%), while Hispanic (2.6%) and white (74.5%) enrollment approximates their percentage of the total Virginia student population. Female student enrollment (42.2%) is approximately 7 percentage points less than female percentage of the population (49.6%).

- Male students dominated the Virginia Junior Academy of Science physical sciences (chemistry, physics, and engineering) competition by almost a 2-to-1 margin, 65 percent to 35 percent. Female students dominated the life sciences (biology and genetics) to approximately the same degree, 67 percent to 33 percent.

- A review of diplomas received by 1990 Virginia graduates indicates that the percentage of black students was lower than other Virginia students who earned advanced studies diploma (23%), while Hispanic students received advanced studies diplomas at a similar rate (38%) to the average for all Virginia students (39%).

- In the NAEP study 2 percent of black students attained the highest proficiency level of 300, while 19 percent of white students attained the same level.

- Differences between the percentages of females (14%) and males (17%) in Virginia who achieved at level 300 on the NAEP assessment were not statistically significant.

RECOMMENDATIONS

The Department of Education should form a team of mathematics, science, and technology educators to plan a symposium with the goal of developing a strategic plan to address increasing the participation (enrollment) and achievement of black, Hispanic, and female students in these disciplines. The symposium agenda should consider, but not limit discussion to, the following potential intervention activities and strategies.

- Develop special pre-school mathematics, science, and technology readiness programs. Such programs have been modeled in Virginia, but on a very small scale. (The Dwight D. Eisenhower Mathematics and Science Education Act)

- Develop special programs for secondary students such as after-school and Saturday enrichment programs. Such programs, targeted at underrepresented students, have provided mathematics, science, and technology enrichment both nationally and in Virginia for several years. (National Science Foundation)

- Provide mentorship, scholarship and internship programs and job shadowing opportunities by business/industry and the public sector. These programs have been modeled in Virginia's science and technology magnet schools. (Student Enrollment Survey)

- Improve teacher training through instructional modules that address the special educational needs of black, Hispanic, and other underrepresented students. Teacher recruitment practices that recognize the need for appropriate role models for minority and female students should also be a consideration. (National Science Foundation, Student Enrollment Survey)

- Develop programs for parents that prepare them to assist their children in making course selection decisions and consider career choices in mathematics, science, and technology. (Student Enrollment Survey)

- Develop mathematics and science enrichment programs outside of the public secondary setting that are supported cooperatively by the Board of Education, the State Council of Higher Education, and business and community organizations. Such programs could increase the interest and achievement of minority and female students in mathematics and science and provide access to such programs for a larger number of students. (National Science Foundation)

- Develop and implement classroom instructional strategies that encourage female students to pursue advanced physical science courses and mathematics studies. (Southeastern Consortium for Minorities in Engineering)

The strategic plan developed should be integrated into the Department of Education's educational reform plans such as World Class Education (WCE) and Virginia Quality Education for Science and Technology (V-QUEST).

It is further recommended that each individual school division evaluate the distribution of its student population in applied/general, academic, and advanced academic mathematics, science, and technology courses, by gender and ethnicity. If minority/female participation rates are revealed to be lower than that of white/male students, a local strategic plan should be developed and implemented to address increasing the participation rate of the underrepresented.

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APPENDICES

APPENDIX A

Statistical Analyses of Enrollment Data

Statistical Analyses of Data

For the kind of data collected for this project, the large-sample test for comparing two binomial proportions was chosen as being most appropriate. This is a test that is useful for many practical research problems. This test compares the difference in proportions between any two groups. The test results in a z-score, from which the significance of the difference between the two groups can be determined. For the purpose of these data analyses, a z-score of 2.58 was used to determine if a difference between two groups was statistically significant. The results of these analyses for mathematics and science apply only to the sample of divisions in the project and cannot be generalized to the state as a whole. A random sample of divisions or schools would be necessary for such a generalization. The results for technology education are based on VERS2 data which also may affect the results since enrollments are unduplicated counts of students in courses; a student is counted only once even if enrolled in more than one course. Enrollment in each course could produce different results.

The following elements were used for all of the statistical tests in this appendix:

1. Research hypothesis (H_1)-what is to be verified.
   $H_1: p_1 - p_2 \neq 0$
   There is a difference between the proportions.

2. Null hypothesis (Ho)-what is to be tested.
   $H_o: p_1 - p_2 = 0$
   There is no difference between the proportions.

3. Test statistic-the number computed from the data. For this test a z-score is computed.

4. Rejection region-values for the test statistic where the null hypothesis can reasonably be rejected. For these data a two-tailed test with an alpha level of .01 was used. A z-score greater than 2.58 was significant in either direction (plus or minus). If the z-score was greater than 2.58 from zero, the null hypothesis of no difference was rejected, and it was concluded that the two proportions were different, at a probability level of .01.

The test statistic was then computed, and the null hypothesis accepted or rejected. In the twenty-nine comparisons made, there were only three instances in which there was not a statistically significant difference between proportions. They were: the difference in proportions in science academic courses for Hispanics and whites; principles in technology education for blacks and whites; and production in technology education for Hispanics and whites.

Results of the Large-Sample Test for Comparing Two Binomial Proportions

Science Course	Enrollment		Proportion	z	Significant?
Total	Black	24918			
	White	95368			
Applied Courses	Black	4568	0.183		
	White	11564	0.121	25.6	Y
Academic Courses	Black	19967	0.801		
	White	79484	0.833	11.93	Y
Advanced Courses	Black	446	0.018		
	White	4320	0.045	19.7	Y
Total	Hispanic	2441			
	White	95368			
Applied Courses	Hispanic	387	0.159		
	White	11564	0.121	5.6	Y
Academic Courses	Hispanic	1999	0.819		
	White	79484	0.833	1.9	N
Advanced Courses	Hispanic	55	0.023		
	White	4320	0.045	5.3	Y
Total	Male	65492			
	Female	64393			
Applied Courses	Male	9433	0.144		
	Female	7471	0.116	15	Y
Academic Courses	Male	53462	0.816		
	Female	53992	0.838	10.6	Y
Advanced Courses	Male	2597	0.040		
	Female	2930	0.046	5.2	Y

Mathematics Course	Enrollment	Proportion	z	Significant?
Total Black	29551			
White	108427			
Applied Courses Black	11166	0.391		
White	20589	0.190	74	Y
Academic Courses Black	16568	0.580		
White	77269	0.713	49.3	Y
Advanced Courses Black	817	0.029		
White	10569	0.097	37.5	Y
Total Hispanic	3322			
White	108427			
Applied Courses Hispanic	992	0.299		
White	20589	0.190	15.6	Y
Academic Courses Hispanic	2087	0.628		
White	77269	0.713	10.6	Y
Advanced Courses Hispanic	243	0.073		
White	10569	0.097	4.7	Y
Total Male	75378			
Female	73952			
Applied Courses Male	18219	0.242		
Female	15304	0.207	16.7	Y
Academic Courses Male	50145	0.665		
Female	53222	0.720	27.2	Y
Advanced Courses Male	7014	0.093		
Female	6326	0.086	5.3	Y

APPENDIX B

Department of Education Requests for Proposals and Approved Work plan; 91-36 & 46

RFP- Request for Proposal #91-36

Virginia Department of Education

TITLE: PROGRAM TO IMPROVE PARTICIPATION, LEARNING, AND ACHIEVEMENT OF BLACK AND HISPANIC MINORITIES IN SCIENCE, MATH, AND ADVANCED TECHNOLOGIES.

BACKGROUND: There is much evidence and expert opinion which shows the lack of participation and achievement of minorities in science, mathematics and advanced technologies which have their basis in science and math. This seems to be especially true for black and Hispanic minorities. Since there is some evidence, yet inconclusive, that the achievement and participation of minority students in the public schools of the Commonwealth, especially Hispanic and black, is significantly lower than the achievement level for the whole of the student population, an examination of the achievement of students by ethnic affiliation should be accomplished. This information would be extremely valuable in determining the extent to which a disparate situation exists in these instructional areas and provide guidance for implementing appropriate strategies to improve the achievement and participation of minority students in science and mathematics.

STATEMENT OF NEED/PROBLEM: To assess the achievement, participation, and magnitude of disparity of black and Hispanic students in science and mathematics in Virginia; and to develop a battery of proven successful intervention and prevention education programs replication through clearly-defined pilot projects.

The negative consequences of lack of participation and achievement of minorities to the welfare of the total society makes improving learning for these students, in the areas described, an imperative and one which should certainly be within the stated mission of the Virginia Department of Education.

SPECIFIC OBJECTIVES:

- To generate data to examine the hypotheses:
  - black and Hispanic student achievement in science and mathematics is significantly lower than the achievement of the total population of students in Virginia
  - participation of black and Hispanic students in advanced level science and mathematics courses is significantly lower than for the total population of students in Virginia
  - Any other minority populations which might be identified (achievement and participation) in this process.

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RFP- Request for Proposal #_____

Virginia Department of Education

- To establish the magnitude of the disparity among students as cited and thus the degree of need for intervention.
- To identify science education programs which have proven successful at improving the achievement of minority students in science and mathematics.
- To plan for integration of this program into DOE core curriculum, restructuring, V-QUEST, and other DOE reform initiatives.

REQUIRED DELIVERABLES/PRODUCTS: This project should (a) present a report to the Management Group including research and implementation strategies by August 15, 1991, (b) generate information to guide the development and implementation of educational prevention and intervention strategies which could positively impact the effectiveness of teaching and learning science for minority students (Black and Hispanic) statewide. Such information would (c) provide the impetus to develop innovative instructional programs designed to specifically address the needs of minority students relative to academic performance in science and mathematics. Such prevention and intervention programs might be developed as community/school cooperative efforts, special residential programs at colleges and universities, community based education projects, development and disseminate of effective strategies through existing school professional development programs and/or pre-and in-service teacher preparation programs.

The report would address each of these areas and non-traditional program models developed for recommending to local schools.

LIMITATIONS:

RESPONSES ARE DUE TO DEBBIE ELLISON ON: May 7, 1991

AWARD WILL BE MADE ON: May 16, 1991

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RFP- Request for Proposal #7146

Virginia Department of Education

TITLE: ACHIEVEMENT AND INTERVENTION STRATEGIES OF FEMALE (BLACK AND HISPANIC) STUDENTS IN SCIENCE, MATHEMATICS, AND ADVANCED TECHNOLOGIES

BACKGROUND: There is much evidence and expert opinion in Virginia and the nation which decries the lack of participation and achievement of female students in science, mathematics and advanced technologies which have their basis in science and math. This seems to be especially true for black and Hispanic female minorities. Since there is some evidence, yet inconclusive, that the achievement and participation of female students in the public schools of the Commonwealth is significantly lower than the achievement level for the whole of the student population, an examination of the achievement of female students should be accomplished. This information would be extremely valuable in determining the extent to which a disparate situation exists in these instructional areas and provide guidance for implementing appropriate strategies to improve the achievement and participation of female students in science and mathematics under the restructured DOE.

STATEMENT OF NEED/PROBLEM: The proposed project will generate information to guide the development and implementation of educational intervention strategies in the Commonwealth which could positively impact the effectiveness of teaching and learning of science and math among female students.

The proposed project relates directly to the goal of providing equity of educational opportunity for all students of the Commonwealth.

SPECIFIC OBJECTIVE: The restructured Department of Education should develop and implement a program strand having the following general goals and considerations:

- To develop a databank to examine the hypotheses:
  - female student achievement in science and mathematics is significantly lower than the achievement of the male student population in Virginia
  - participation of female students in advanced level science and mathematics courses is significantly lower than for the male student population in Virginia.

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RFP- Request for Proposal #_____

Virginia Department of Education

- To establish the magnitude of the disparity between male and female students as cited and thus demonstrate the need to identify the degree and place for intervention strategies.

- To identify mathematics and science education intervention strategies which have proven successful at improving the achievement of female students of science and mathematics and to provide integration recommendations for the core curriculum.

REQUIRED DELIVERABLES/PRODUCTS: Report on research and successful science programs and strategies for science, mathematics, and advanced technology instruction for females. Integration with the DOE core curriculum and restructuring goals is critical.

LIMITATIONS:

- Availability of quality research.

RESPONSES ARE DUE TO DEBBIE ELLISON ON: 7-24-91

AWARD WILL BE MADE ON: 7-18-91

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Program to Improve Participation, Learning, and Achievement of Black and Hispanic Minorities in Science, Mathematics and Advanced Technologies
#91-36

SUMMARY OF APPROACH PROPOSED:

This proposal aims to study and confirm perceived discrepancies in the participation and achievement of African American and Hispanic students in comparison to majority population students in Virginia public schools. The study involves the examination of the achievement and participation of minority students in the areas of mathematics, science, and advanced technologies as represented in Virginia public schools.

The project team will engage in the collection of data on student participation and achievement in mathematics, science, and advanced technology courses. The data will be analyzed to determine the extent to which there is a discrepancy between the achievement and participation of selected minority groups and the majority group in Virginia public schools. Results of the study will be summarized in a report to the Department of Education Management Team, accompanied by team recommendations and descriptions for initiatives to improve student achievement. Because some aspects of this study overlap with aspects of the study on tracking and ability grouping, some of the project work can facilitated by collaboration and the sharing of data.

IMPLEMENTATION PLAN/METHODOLOGY:

	Activity	Staff	Time Schedule
1.	Conduct full team meeting to review technical aspects of project; Review the strategic plan for collection and evaluation of data	Cotman and full team	May 20-24
2.	Identify advanced course offerings in Virginia in science, mathematics, and technology (use available data from the study of tracking/ability grouping in Virginia)	Cotman Willcox Rezba Ayers	June 1-30

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	Activity	Staff	Time Schedule
3.	Determine other minority populations which should be considered for performance and participation discrepancies	Cotman Rezba Willcox Hylton	May 20-30
4.	Identify research method to be used in the study (study requires comparison of participation and achievement data of selected minority populations with data of majority population; Develop research design	Cotman Rezba Firebaugh Keeling	May 20-30
5.	Identify indicators of student achievement in science, mathematics, and technology (e.g., S.A.T. scores, ITBS scores, course grades, participation in advanced competitions and special programs	Cotman Willcox Rezba	May 20-30
6.	Identify indicators of student participation in science, mathematics, and technology (e.g., course enrollment data)	Cotman Willcox Rezba	May 20-30
7.	Collect data	Cotman Rezba Willcox Ayers Firebaugh Bryant	June 1-July 20
8.	Analyze data collection; determine the extent to which there is a discrepancy between the performances and achievement of selected minority groups and the majority group	Cotman Rezba Firebaugh Keeling Willcox Bryant	July 20-25

	Activity	Staff	Time Schedule
9.	Develop conclusions from analysis of data	Cotman Rezba Firebaugh Keeling Willcox Bryant	July 25-30
10.	Develop questionnaire and survey selected states to identify successful initiatives for improvement of science, mathematics, and technology participation and achievement of minority students, prepare summary report; use computer links in Departments of Education across the nation	Cotman Hylton Bryant Rezba Ayers	July 1-30
11.	Contact professional organizations to identify effective programs for improvement of minority achievement	Bryant Firebaugh Willcox	May 15-July 1
12.	Extrapolate factors such as teaching conditions, policy statements, administrative procedures, etc. which seem to have positive and negative impact on minority achievement; prepare a written summary	Cotman Rezba Willcox Firebaugh Bryant Hylton	July 25-30
13.	Prepare segment of report on recommendations for intervention and prevention strategies in LEA's, teacher preparation, community-based programs, partnerships, etc.	Cotman Rezba Firebaugh Ayers Willcox Hylton	July 25-30

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	Activity	Staff	Time Schedule
14.	Design a plan for integration of prevention and intervention strategies for minority achievement with Department of Education reform initiatives such as the Virginia Common Core of Learning; Restructuring of Education, K-12; V-QUEST, Challenge 2000, Xerox Project, etc.	Cotman Rezba Hylton Bryant Willcox	July 25-30
15.	Prepare the final report for the DOE Management Team	Cotman Rezba Firebaugh Willcox Bryant	~~August 1-10~~ Nov. 1, 1991

DELIVERABLES PROPOSED (REQUIRED AND ADDITIONAL):

A report which summarizes aspects of a research study on the participation and achievement of African American and Hispanic students in science, mathematics, and advanced technologies in Virginia public schools, including

- –research and implementation strategies
- –information to guide the development and implementation of prevention and intervention strategies for teaching and learning in Virginia schools
- –suggestions for innovative instructional programs for minority students (community/school cooperative efforts, special residential programs at colleges and universities, community-based education projects)
- –suggestions for professional development programs and pre- and in-service teacher preparation initiatives

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BUDGET TO INCLUDE DIRECT AND INDIRECT COSTS, OUTSIDE RESOURCES, PURCHASED SERVICES, AND ESTIMATE FOR FTE'S REQUIRED:

	Activity	FTE's	Cost
1.	Conduct full team meeting	2 hours	——
2.	Identify course offerings	12 hours	——
3.	Determine minority populations	4 hours	——
4.	Identify research methodology	4 hours	——
5.	Identify indicators of student achievement	6 hours	——
6.	Identify indicators of student participation	6 hours	——
7.	Collect data	30 hours	$500
8.	Analyze data collection	15 hours	$200
9.	Develop conclusions	10 hours	——
10.	Develop questionnaire and survey selected states	12 hours	$300
11.	Contact professional organizations	9 hours	$300
12.	Extrapolate factors	10 hours	——
13.	Prepare segment of report	10 hours	——
14.	Design plan for integration	12 hours	——
15.	Prepare final report for DOE Management Team	15 hours	——

LIST OF STAKEHOLDERS AND INTENDED AUDIENCES:

- Department of Education
- Students – particularly minority students who are African American and Hispanic
- Institutions of higher education
- LEA's in Virginia
- Teachers of science, mathematics, and advanced technology education
- future employers of minority students graduating from Virginia public schools

EVALUATION PLAN TO INCLUDE INDICATORS OF PROJECT SUCCESS:

- Timely submission of report to the DOE Management Team

- Assessment by a panel of 15 experts or practitioners in science, mathematics, and technology education (teachers and supervisors in these content areas, instructors in higher education, etc.) to determine perceptions of usefulness of research findings and predictions for impact on student achievement and participation for minority students in science, mathematics, and technology education

APPENDIX C

Student Enrollment Survey Form

STUDENT ENROLLMENT SURVEY

DIRECTIONS: Please provide 1990-91 enrollment information appropriate to your school's organization. *Specifications for racial/ethnic categories are listed below. Thank you.

1. Indicate the total number of students enrolled, by grade.

_____ grade 7	_____ grade 10
_____ grade 8	_____ grade 11
_____ grade 9	_____ grade 12

2. Indicate by racial/ethnic category, gender, and grade, the total number of students enrolled.

	American Indian	Asian American	Black	Hispanic	White
	M/F	M/F	M/F	M/F	M/F
Grade 7	___/___	___/___	___/___	___/___	___/___
Grade 8	___/___	___/___	___/___	___/___	___/___
Grade 9	___/___	___/___	___/__	___/___	___/___
Grade 10	___/___	___/___	___/___	___/___	___/___
Grade 11	___/___	___/___	___/___	___/___	___/___
Grade 12	___/___	___/___	___/___	___/___	___/___

* Specifications for racial/ethnic categories:

-American Indians (Includes Alaskans)
-Asian & Asian American (includes Pakistanis, Indians & Pacific Islanders)
-Black (includes Jamaicans, Bahamians and other Carribbeans of African but not Hispanic or Arabian descent)
-Hispanic (includes persons of Mexican, Puerto Rican, Central or South American or other Spanish origin or culture)
-White (includes Arabian)

3. Indicate the number of students in the Class of 1991 who received the Advanced Studies Diploma.

American Indian	Asian American	Black	Hispanic	White
M/F	M/F	M/F	M/F	M/F
___/___	___/___	___/___	___/___	___/___

4. Indicate, by racial/ethnic category and gender, the total number of seventh grade students enrolled in pre-algebra (or equivalent course specifically designed to prepare students for Algebra I in the eighth grade).

American Indian	Asian American	Black	Hispanic	White
M/F	M/F	M/F	M/F	M/F
___/___	___/___	___/___	___/___	___/___

5. Indicate, by racial/ethnic category and gender, the total number of eighth graders enrolled in Algebra I during the 1990-91 school year.

American Indian	Asian American	Black	White	Hispanic
M/F	M/F	M/F	M/F	M/F
___/___	___/___	___/___	___/___	___/___

6. Indicate, by racial/ethnic category and gender, the total number of students who scored 1100 or above on the Scholastic Aptitude test (SAT).

American Indian	Asian American	Black	Hispanic	White
M/F	M/F	M/F	M/F	M/F
___/___	___/___	___/___	___/___	___/___

7. Are students ability-grouped for the following courses? If so, how many levels are available?

	Yes	No	# of Levels
Earth Science	___	___	___
Biology	___	___	___
Chemistry	___	___	___
Physics	___	___	___
Algebra I	___	___	___
Algebra II	___	___	___
Geometry	___	___	___

8. List incentives which would encourage female, ethnic minority and low family income students to enroll in science and math courses.

_____

_____

_____

_____

9. List strategies and initiatives which would increase the academic achievement and critical thinking skills of female, ethnic minority and low income students such that they are better prepared for work and higher education?

_____

_____

_____

_____

_____ _____ _____

Survey Completed By School Division Date

_____

School

APPENDIX D

Data Summary for Science, Mathematics and Technology

APPLIED, ACADEMIC, AND ADVANCED SCIENCE COURSE ENROLLMENT BY ETHNIC GROUP AND SEX

	Am Ind/Alskn				Asn/Pac-Is				Black				White				Hispanic				State				
	M	F	T	PER	M	F	T	PER	M	F	T	PER	M	F	T	PER	M	F	T	PER	TOTAL	PER	MALE		FEMALE	
Applied	18	10	28	0.2%	203	154	357	2.1%	2471	2097	4568	27.0%	6517	5047	11564	68.4%	224	163	387	2.3%	16904	13.0%	9433	55.8%	7471	44.2%
Academic	82	78	160	0.1%	2975	2869	5844	5.4%	9407	10560	19967	18.6%	32924	39560	72484	74.0%	1074	925	1999	1.9%	107454	82.7%	53662	49.8%	54922	50.2%
Advanced	1	7	8	0.1%	363	335	698	12.6%	153	293	446	8.1%	2052	2268	4320	78.2%	28	27	55	1.0%	5527	4.3%	2597	47.0%	2930	53.%
Total	101	95	196	0.1%	3541	3358	6899	5.3%	12031	12950	24981	19.2%	48493	46875	95368	73.4%	1326	1115	2441	1.9%	129885		65492	50.4%	64321	49.6%

APPLIED, ACADEMIC, AND ADVANCED MATHEMATICS COURSE ENROLLMENT BY ETHNIC GROUP AND SEX

	Am Ind/Alskn				Asn/Pac-Is				Black				White				Hispanic				State				
	M	F	T	PER	M	F	T	PER	M	F	T	PER	M	F	T	PER	M	F	T	PER	TOTAL	PER	MALE		FEMALE	
Applied	38	20	58	0.2%	391	327	718	2.1%	5931	5235	11166	33.3%	11275	9314	20589	61.4%	586	408	992	3.0%	33523	22.4%	18219	54.3%	15304	45.7%
Academic	63	81	144	0.1%	3273	3126	6399	6.2%	7584	8984	16568	16.2%	38124	39145	77269	75.4%	1101	986	2087	2.0%	102667	68.6%	50145	48.9%	52522	51.1%
Advanced	11	12	23	0.2%	930	756	1686	12.6%	376	441	817	6.1%	5573	4996	10569	79.2%	124	119	243	1.8%	13340	8.9%	7014	52.6%	6326	47.4%
Total	116	113	227	0.2%	4594	4209	8803	5.9%	13892	14662	28551	19.1%	54972	53455	108427	72.6%	1809	1513	3322	2.2%	149330		75378	50.5%	73952	49.5%

TECHNOLOGY EDUCATION PROGRAM ENROLLMENT BY ETHNIC GROUP AND SEX

	Am Ind/Alskn				Asn/Pac-Is				Black				White				Hispanic				State				
	M	F	T	PER	M	F	T	PER	M	F	T	PER	M	F	T	PER	M	F	T	PER	TOTAL	PER	MALE		FEMALE	
Principles of Tech	0	0	0	0.0%	3	0	3	6.3%	6	5	11	22.9%	26	8	34	70.8%	0	0	0	0.0%	48	0.2%	35	72.9%	13	27.1%
Communications	136	21	157	1.3%	647	146	793	6.6%	1150	221	1371	11.4%	7350	1518	8868	74.0%	654	141	795	6.6%	11984	43.0%	9937	82.9%	2047	17.1%
Production	209	15	224	1.5%	550	173	723	5.0%	2495	402	2897	20.0%	8450	1100	9550	65.9%	968	126	1094	7.6%	14488	52.0%	12672	87.5%	1816	12.5%
Transportation	3	1	4	0.3%	96	1	95	7.0%	137	7	144	10.6%	815	19	834	61.3%	278	6	284	20.9%	1361	4.9%	1327	97.5%	34	2.5%
Total	348	37	385	1.4%	1294	320	1614	5.8%	3788	635	4423	15.9%	16641	2645	19286	69.2%	1900	273	2173	7.8%	27881		23971	86.0%	3910	14.0%

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APPENDIX E

Virginia Science and Technology Magnet Schools Enrollment by Ethnicity and Gender

SCIENCE AND TECHNOLOGY MAGNET SCHOOL ENROLLMENT BY ETHNICITY AND GENDER

SCHOOL	Black Enrollment		Hispanic Enrollemnt		White Enrollment		Other Enrollment		Male Enrollment		Female Enrollment		Total
	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Enrollment
New Horizon	4	4.5	1	1.1	72	80.9	12	13.5	51	57.3	38	42.7	89
Central Virginia	8	8.2	0	0	84	86.6	5	5.2	51	52.6	46	47.4	97
Roanoke	13	6.3	0	0	187	90.8	6	2.9	122	59.4	84	40.2	206
Southwest Virginia	3	4.8	0	0	55	88.7	4	6.5	36	58.1	26	41.9	62
Thomas Jefferson	61	3.7	53	3.2	1168	70.6	373	22.5	95	57.9	696	42.1	1655
TOTALS	**89**		**54**		**1572**		**394**		**1219**		**890**		**2109**

APPENDIX F

Secondary Mathematics, Science, and Technology Course Offerings

SECONDARY SCIENCE, MATHEMATICS, AND TECHNOLOGY

COURSE OFFERINGS

This appendix lists the science, mathematics, and technology courses offered in Virginia public secondary schools and categorizes them by type. (The technology education courses in the data sample were obtained from the 1990-91 VERS report.)

Applied/General Courses. Applied/general courses are traditionally designed with content and expectations differentiated for students perceived to be of lower ability, or perceived to lack appropriate preparation for academic courses. Students who pursue these courses are generally not expected to attend college, but to immediately enter the work force upon graduation. These courses give credit toward the standard diploma.

Academic Courses. Academic science courses prepare students for post-secondary education as well as job entry in some technical fields. These courses give credit for both the advanced studies and the standard diplomas.

Advanced Academic Courses. Advanced academic science courses are offered in Virginia secondary schools for students with exceptional interest and/or aptitude for science topics. These courses are offered either as Advanced Placement programs, or locally selected second level courses such as Biology II, oceanography, or Chemistry II. These courses are offered to students who have completed prerequisite academic courses and meet other prerequisites.

Technology Education Courses. The technology education program for high school provides challenging experiences and ensures the self-actualization of the adolescent learner. The curriculum is formulated from experiences with technological resources and systems. Program content stems from the study of technologies and challenges the student's ability to apply scienfific principles, engineering concepts, and technological systems.

Secondary schools in Virginia are required by The Standards for Accrediting Schools to offer four academic science and mathematics courses in their program of studies. Courses may be selected from the lists of applied/general and advanced academic categories for inclusion as well. The number and type of applied/general and advanced academic courses selected for inclusion in a secondary school's program of studies is a local school division decision.

SCIENCE COURSES

Applied/General

Applied Earth Science
Applied Biology
Applied Physical Science
Consumer Chemistry
Applied Physics

Academic

Earth Science
Biology I
Chemistry I
Physics I

Advanced Academic

Geology
Oceanography
Astronomy
Biology II
Advanced Placement Biology
Chemistry II
Advanced Placement Chemistry
Physics II
Advanced Placement Physics

MATHEMATICS COURSES

Applied/General

General Mathematics I
Applied Mathematics
Consumer Mathematics
Basic Algebra
Informal Geometry

Academic

Algebra I
Algebra I, Part I
Algebra I, Part II
Algebra II
Intermediate Algebra/Trigonometry
Geometry

Trigonometry
Advanced Algebra/Trigonometry
Advanced Mathematics
Computer Mathematics

Advanced Academic

Mathematics Analysis
Elementary Mathematics Functions
Calculus
Analytical Geometry
Advanced Placement Calculus
Multivariant Calculus
Advanced Placement Computer Science
Probability and Statistics

TECHNOLOGY COURSES*

Principles of Technology Program

Principles of Technology I
Principles of Technology II

Communication Program

Basic Technical Drawing
Architectural Drawing
Engineering Drawing
Electricity and Electronics I
Electricity and Electronics II
Graphic Arts

Production Program

Materials and Processes
Construction
Manufacturing

Transportation Program

Transportation
Energy and Power.

* The technology education courses listed above were reported in the 1990-91 VERS report.

Trigonometry
Advanced Algebra/Trigonometry
Advanced Mathematics
Computer Mathematics

Advanced Academic

Mathematics Analysis
Elementary Mathematics Functions
Calculus
Analytical Geometry
Advanced Placement Calculus
Multivariant Calculus
Advanced Placement Computer Science
Probability and Statistics

TECHNOLOGY COURSES*

Principles of Technology Program

Principles of Technology I
Principles of Technology II

Communication Program

Basic Technical Drawing
Architectural Drawing
Engineering Drawing
Electricity and Electronics I
Electricity and Electronics II
Graphic Arts

Production Program

Materials and Processes
Construction
Manufacturing

Transportation Program

Transportation
Energy and Power.

Pre-Engineering

* The technology education courses listed above were reported in the 1990-91 VERS report.

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